



## CONTRACT N°: IEE/13/886/SI2.674899 TITLE: REFURBISHMENT OF THE PUBLIC BUILDING STOCK TOWARDS NZEB

ACRONYM: REPUBLIC\_ZEB

# REPORT D2.2: METHOD AND RESULTS IN DEFINING NATIONAL REFERENCE BUILDINGS FOR EACH BUILDING CATEGORY



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## **Project consortium**

	BME	WP3 Leader
bre	BRE	WP6 Leader
BSERC black see energy research centry	BSERC	WP2 Leader
CRES CONTRE FOR RENEWABLE	CRES	Partner
	CTI	WP1-WP7 Leader Coordination
EIHP	EIHP	Partner
URBAN INCD INCERC	URBAN-INCERC	Partner
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LNEG	LNEG	WP5 Leader
	MACEF	Partner
	POLITO	WP 4 Leader
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## **Project overview**

The RePublic\_ZEB project is focused on the energy and CO<sub>2</sub> emissions associated with existing public buildings and their refurbishment towards nZEB.

The **<u>core objective</u>** of the project is to:

• Define costs-benefit optimized "packages of measures" based on efficient and qualityguaranteed technologies for the refurbishment of the public building stock towards nZEB that are standardized and adopted by builders and building owners.

From this stems three **<u>basic objectives</u>**:

- (i) State-of-the-art assessment of the public building stock through a country-specific evaluation of the energy consumption and CO<sub>2</sub> emissions;
- (ii) Define reference buildings; and;
- (iii) Develop a common framework and a harmonized methodology for the definition of a nZEB concept for public buildings.

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### LIST OF ABBREVIATIONS

СОР	Coefficient of performance
DHW	Domestic hot water
EER	Energy efficiency rating
EPC	Energy performance certificate
GF	Ground floor
GHG	Green house gas
ISO	International Organization of Standardization
nZEB	Nearly-zero energy buildings
RES	Renewable energy sources
SPEC	Specific primary energy consumption
VRF	Variable refrigerant flow
WP	Work package
$CO_2$	Carbon dioxide

### **EXECUTIVE SUMMARY**

This document represents Deliverable (D2.2), which contains the results of the second stage of the work within WP2 - Method and results in defining national reference buildings for each class. Deliverable D2.1: "Report on the preliminary assessment of public buildings stock" includes detailed information regarding public buildings in the eleven countries, covered by the project. As a result of the adopted definition of reference buildings and the carried out analyses of the public building stock, a preliminary selection of reference buildings has been made.

Based on this information, **Chapter II: Selection of Building Categories** of the current report contains the final list of building categories, reference buildings of which have been chosen for further detailed analysis.

The following criteria have been applied for the choice of representative categories:

- Building conditioned area, m2,
- o Specific final/primary energy consumption, kWh/m2.year, and/or
- o Quantity of CO2 emission equivalent of the specific energy consumption, kg/m2.year

In line with the RePublic\_ZEB Grant Agreement, each country has presented at the minimum two categories of buildings. However, depending on the importance of certain categories in given countries this number has been increased to 4-5.

**Chapter III: Selection of Reference Buildings,** presents the choice of reference buildings for each building category, based on the following criteria:

- Built-up/conditioned floor area;
- Building age;
- Construction materials and corresponding thermal properties of the building envelope;
- Occupancy schedule;
- Technical systems/installations for maintaining the built environment;
- Operational pattern;
- Energy carriers used for heating.

Necessary data were seek for each country targeted by the project, starting from official information available through the national and regional specialized institutions, as well as using the results of existing studies. In cases when relevant data were not found, the use of default data was agreed.

The whole information is presented in the form of tables, which have been developed for the aims of this particular investigation. This approach allows the application of building energy modelling and simulation for obtaining the energy performance of the buildings in WP4. The building energy model encompasses 12 groups of necessary information: geometrical, internal gains and operational schedule, building energy usage, base heat supply regime (type of the heating system, energy resource etc.), cooling mode and system, ventilation etc., which would allow performing simulation of the energy consumption.

The sets of relevant information concerning the eleven countries, covered by the project, are included as an Appendix to the main report.

## **1** Introduction

The achievement of best results from the project work is determined by the choice of building categories for further analysis, which have the biggest influence on the generation of  $CO_2$  emissions. It is expected that these shall be the categories of buildings with the highest energy consumption, although the emissions, to a great extent, depend also on the type of energy consumed and its emission factors.

The available information regarding public buildings does not allow getting deeply into the structure and emission characteristics. That is why, for the needs of the buildings classification in the current study, it is assumed to use characteristics such as conditioned area and specific final or primary energy consumption for unit conditioned area, which define the greatest energy saving potential.

A reference building could be a real or imaginary building, which to the greatest extent reflects the performance of the group/category it represents. Usually, depending on the performance of each building category, it becomes necessary to include sub-categories and therefore, to choose several reference buildings, which would make the investigation sounder.

Despite the similarity of the definitions of the buildings classes, it is possible to notice significant differences in their relative weight in the overall building stock of the given countries. This is due to the difference in the ownership of the used public buildings.

## 2 Selection of building categories

The nowadays' energy policy rests upon the pursuit of climate protection through admissible energy comfort for consumers. This aim is obligatory also while choosing categories of buildings and hence, it defines the performance of the specific criteria. These criteria should help the forthcoming investigation to reach maximum effectiveness, and through the proposed measures for improvement of consumption's efficiency – the highest reduction of GHG emissions. This requirement could be met by criteria, which reflect both the volume of the used energy by category, and the effectiveness of consumption; and at the end – the biggest reduction of emissions with observation of consumers' comfort.

The choice can be done without following formal procedures, but with consideration of the above argumentation.

The first apparent criterion is the **conditioned area** relevant to the given building category. It is the first-rate indicator, which defines the volume of the energy needed for conditioning, while observing the restrictions of space comfort. It defines the potential for saving of energy, of course depending on the specific primary energy consumption.

Obviously, the building's **total floor area** is not the needed accurate indicator, but its application is acceptable in situation when no information is available about the conditioned area.

The mentioned **specific primary energy consumption** (SPEC) is the second valuable indicator, which, thanks to its omnipurposeness incorporates also the efficiency of conversion processes. Through them it reaches the consumers and successfully adds value to the first indicator (conditioned area).

The inevitable conversion inaccuracies during the SPEC identification reduce the accuracy of this indicator and make it not better than the **specific final energy consumption** indicator. Connection between both indicators is the efficiency of conversion, which highly depends on the type of energy used and the efficiency of the used national and local energy technologies. For example, electricity

generated by thermal power plants loses 70% of fuel's energy until it reaches the consumers connected to the low voltage grid.

These three indicators are sufficient to choose the buildings categories; however, if information is available, it is advisable to use the direct indicator - **CO2 emissions equivalent**. Of course, for large groups of buildings it is also tentative.

Resting on the above considerations, the basic approach proposed for selection of categories of buildings, for which representative buildings for further cost-benefit analysis will be determined, includes assessment of the building classes identified at the previous stage, observing the importance and the magnitude of the following indicators:

- $\circ$  Building conditioned area, m<sup>2</sup>,
- Specific final/primary energy consumption, kWh/m<sup>2</sup>.year, and/or
- $\circ$  Quantity of CO<sub>2</sub> emission equivalent of the specific energy consumption, kg/m<sup>2</sup>.year

Each partner had to select 2-3 or more building categories.

Of course, each country could, according to the specific features of given groups of buildings, examine categories, which do not entirely meet the proposed indicators but are important for the country due to other specific reasons.

#### 2.1 Bulgaria

Deliverable (D2.1) provides information about the public building stock categories, which allows making the choice. In Bulgaria, the overwhelming class of buildings are the educational ones with the share of more than 75,4% of the total conditioned area. These have to be unconditionally included in the study. Three out of the seven remaining categories have been selected, due to their high specific consumption, despite their small share in the total conditioned area. The information regarding the selected building categories is presented in the table below.

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m <sup>2</sup> year	CO2 emission equivalent, kg/m <sup>2</sup> .year	
Residential	6,6	161,6	n/a	
Offices/Public administration	3,1	138,1	n/a	
Educational buildings	75,4	91,8	n/a	
Health-care facilities	6,0	196,68	n/a	

Proposed	classes	for	further	analyses,	Bulgaria
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The following categories of buildings have been chosen: Students' housing, offices, educational buildings, health-care facilities.

The selection of category "Students' housing" was made because the exploitation of these buildings coincides with that of the residential buildings, which represent a significant part of the whole building stock. In this way the residential sector will be assessed as well.

Health-care facilities have to meet very high requirements towards microclimatic parameters and therefore it is necessary to assess the applicability and achievability of the requirements concerning nearly-zero energy consumption for this category.

Educational buildings are a wide-spread category with significant social importance. A considerable part of them includes sports facilities and swimming pools, in which the application of systems that utilize renewable energy is highly economically and ecologically efficient.

Office buildings are visited by significant masses of people and, along with the necessity to maintain the microclimatic parameters (including air cleanness), the application and demonstration of the efficiency of the principles of nearly-zero energy buildings will have a social impact on visitors, will raise their acquaintance and will improve the quality of the services provided.

The selection of the above buildings' categories has been coordinated with the Ministry of Regional Development and Public Works, Ministry of Energy, Sustainable Energy Development Agency, Bulgarian community of HVAC engineers, Bulgarian Association "Doors, windows, double skin facades", as well as with suppliers of modern HVAC and lighting systems. The chosen categories are treated with priority for financial support by the Operational Programmes during the period 2014-2020.

#### 2.2 Croatia

Building stock by use shows three significant uses – healthcare, administrative buildings and residential buildings, built in the period between 1971 and 2005, which have potential in scope of RePublic\_ZEB project. Distribution of buildings between two reference climate which follows general building stock distribution is not available in detail, but 75/25% split may be applied between continental and coastal climate. For residential buildings technological solutions and requirements might be too distinct from non-residential use, and further analysis might not be recommendable.

Building data for public buildings was provided by Ministry for construction and physical planning, as part of the national plan for refurbishment of public building stock, directing the refurbishment to offices and public administration buildings. Further information on building stock energy consumption used in analysis was given by Agency for transactions and mediation in immovable properties, which is running ISGE database of public buildings (collecting data on energy consumption). Total share of buildings stock, possibilities for refurbishment, and expected visibility of nZEB refurbishments directed proposed building uses to office and health care buildings.

Ministry for construction and physical planning is among other in charge of EPBD and EED implementation in Croatia, through adoption of national regulation on energy efficiency in buildings. Agency for transactions and mediation in immovable properties is governmental agency in charge of energy refurbishments of public buildings funded by the Environmental protection and energy efficiency fund.

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m <sup>2</sup> year	CO2 emission equivalent, kg/m <sup>2</sup> .year	
Residential	22	154,27	n/a	
Offices/Public administration	32	118,25	n/a	
Health-care facilities	22	196,81	n/a	

#### Proposed classes for further analyses, Croatia

#### 2.3 Greece

The main criteria for the analysis of the Greek public building stock are:

- o number of buildings,
- $\circ$  total floor area,
- building energy performance (final and primary energy consumption).

This analysis showed three building uses that have considerable impact; offices/public administrative buildings, educational buildings and healthcare buildings. Healthcare buildings are not included because it is very difficult to define one reference building due to the variety of the building structure and use (various health care facilities in each hospital).

In the table below, there are two set of energy data. The first one refers to specific final energy consumption and derives from the National Statistical Service of Greece and other sources (national bibliography, and relevant ministries) and the second one refers to specific primary energy consumption and derives from the EPC database.

	Share of the	National Statis Gre	tical Service of eece	EPC database		
Building category	total conditioned area, %	Specific final energy consumption, kWh/m <sup>2</sup> year	CO2 emission equivalent, kg/m <sup>2</sup> .year	Specific primary energy consumption, kWh/m <sup>2</sup> year	CO2 emission equivalent, kg/m <sup>2</sup> .year	
Offices/Public administration	22,9	136,0	n/a	271,5	153,5	
Educational buildings	52,4	53,5	n/a	101,7	58,8	

#### Proposed classes for further analyses, Greece

As mentioned above, three building uses were preselected based on the number of buildings, total floor area and building energy performance. The data were collected from the National Statistical Service of Greece, the School Buildings Organisation S.A., the Ministry of Health, the Hellenic Agency for Local Development and Local Government, energy audits made by CRES, and the Energy Performance Certificate national database. The analysis showed that hospitals and other institutional care buildings have impact as regards total floor area and energy performance. However, based on the available data from the data collection it results that the building geometry and building use varies significantly and there is no reference building to be defined and describe the majority of this building use.

#### 2.4 Hungary

The selection of reference building categories was made on the basis of the National Building Energy Strategy. The document contains reliable information about the Hungarian building stock, since it presents the existing status of residential buildings, as well as public buildings, including building numbers, building structures, energy consumption, etc. The document proposes several building retrofitting measures in different levels of refurbishments. The National Building Energy Strategy was prepared by ÉMI Non-Profit Llc on behalf of the Ministry of National Development and was adopted by the government in 2015. ÉMI is a 100% state-owned professional, intellectual competency center in the Hungarian construction industry. ÉMI's service includes, inter alia,

providing technical expertise for preparation of standards and laws. The selection of reference building categories and reference buildings was made by the involvement of ÉMI. In Hungary, the educational buildings represents 60% of the public building stock, therefore it is the building category that was selected firstly. Health-care facility buildings are another building category that has been considered for further analysis in the project, because it represents 15% of the building stock, and almost 20% of the total primary energy consumption. The third significant building class is the office buildings: these buildings have approximately 8% share of the total conditioned floor area. There are a number of residential buildings owned by central or local authorities, therefore this class was also selected, although there is not available information yet about the share of residential buildings in the public building stock. To sum up, educational, health-care facility, office and residential buildings have been selected as representative building categories of Hungarian public building stock.

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m <sup>2</sup> year	CO2 emission equivalent, kg/m <sup>2</sup> .year	
Health care facilities	15,2	282	n/a	
Offices / Public administration	7,5	226	n/a	
Educational buildings	60,1	230	n/a	
Residential	n/a	n/a	n/a	

#### Proposed classes for further analyses, Hungary

#### 2.5 Italy

The main criteria applied for the Italian analysis of the public building stock are:

- building end use;
- public ownership and/or use;
- number of buildings;
- total floor area;
- primary energy consumption for heating, DHW, cooling and lighting.

First of all, different building categories have been considered, according to their public use and/or ownership. For the same categories, the building consistency has been defined. Finally, data on the building primary energy consumption for heating and DHW (conversion factor, 1) and the electricity use for cooling and/or lighting for the non-residential categories (conversion factor, 2,17) have been collected.

#### Italian public building stock definition through indicators

	P	UBLIC	Number	Number Total floor of units area, m <sup>2</sup> Heatin DH	SPECIFIC PRIMARY ENERGY CONSUMPTION, kWh/m <sup>2</sup> a			
Building category	Use	Ownership	of units		Heating and DHW	Cooling and/or lighting	Global	
Residential	Х	Х	90 000	-	177	-	177	

(Social housing)		Х					
Offices	Х	Х					
(Public admin.)	Х		13 700	23 600 000	127	119	246
(Local authorities)							
Education	Х	Х	52 000	73 400 000	111	41	150
(Schools)	Х		52 000	73 400 000	111	41	132
Hotels	Х		25 845	48 600 000	150 heating 200 DHW	217	567

Table IT.1 shows the considered categories generally owned and not only attended by publics; with the exception of the hotels. Schools are the category with the highest total floor area; the social houses total floor area is not available, however the number of residential buildings let suppose a high value. Concerning the energy consumption:

- the offices and the residential buildings get the same specific primary energy consumption;
- $\circ$  the social houses energy need for heating and DHW is really high; that is a mean value defined by considering the whole country, peak values arise up to 250 kWh/m<sup>2</sup>a;
- the schools energy need for heating and DHW could be compared to that of offices, but the electrical consumption is lower because of the minor amount of cooling systems and facilities in general;
- $\circ$  the hotels are an exception, for the relevant use of DHW and electricity referred to the given building services.

The Italian government is particularly interested in offices and schools energy refurbishment, these two categories have thus been chosen for the next work steps. Despite the high energy consumption, hotels have not been chosen for further analysis because this category in Italy is not properly considered as public. Table IT.1 shows also the high number of residential buildings in Italy owned by publics and generally used by privates; this strong impact as well as the high energy consumption referred to this category led to the choice the social houses is the third category to be considered for the further project work, unlikely the lack of available data.

Social houses, schools and offices are thus the three categories considered in Italy for the refurbishment of the public building stock towards nZEB. This selection has been taken and confirmed after a consultation with the Italian Ministry for the Economic Development (MiSE; responsible for the adoption of the EPBD in Italy) through the first "on on one" meeting (as activity of WP5 of the project in December 2014). The same categories have been also included in the "National Plan for nZEB", presently under development by MiSE. In the consultation process, also the Energy Departments of two important regions (Lombardy and Piedmont in which is present the 25% of the Italian population) have been involved.

#### 2.6 Portugal

The criteria for identifying the reference building in study, follows the analysis of the Portuguese public building stock developed in the report D2.1. As was suggested in the end of this deliverable, the following categories were identified: office and educational buildings should be considered as main categories taking into account a significant impact in terms of building floor surface and energy consumption at the level of building stock. Residential building (social housing) and Health (hospitals) were suggested as well, as second categories that could be considered taking into

account the impact in terms of building floor surface and energy consumption at the level of building stock. The final decision of proposing office buildings and social housing is due to the impact that could bring the rehabilitation process in Portugal. Educational buildings had already pass through rehabilitation process and programs, so another analysis regarding this category is not useful in this stage. Regarding the Health buildings-hospital there exist a large variety in typology representing health buildings, from small health centers to large hospitals and the data available are not very qualitative.

Cost optimal methodology has been applied in Portugal in the case of new building office, need for the methodology applied for existing building (rehabilitation) is still need. In the case of residential buildings, the cost-optimal methodology was applied as well, however the social housing represent a particular case from the point of view of area, geometry and utilization.

The two reference buildings are presented in the following table according with the share of total conditioned area and specific annual final energy consumption categories was mentioned in the one to one meeting.

The data considered for analysis represents the buildings belonging to Public administration, Central authorities and Regional Local Authorities and is based on the information from the EPC data base of National Energy Certification System (SCE). Within first "one to one" meeting with the General Directorate for Energy and Geology, institution responding for the building certification and plans in Portugal, the project and the objectives were presented together with the work plan and explanation of categories of building identified for the analysis.

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m <sup>2</sup> year	CO2 emission equivalent, kg/m <sup>2</sup> .year	
Residential (Social housing)	23	129,02	n/a	
Offices/Public administration	22	48,60	n/a	

#### Proposed classes for further analyses, Portugal

#### 2.7 Romania

Based on the main conclusions of the analysis of public building stock, the two selected representative building categories are (I) Offices/Public administration and (II) Educational buildings. Furthermore, taking into account the consultations with representatives of the relevant national public authority and the outputs of the calculation of cost-optimal levels of minimum energy performance requirements for buildings and building elements, the reference buildings were defined for office buildings (Central authorities – Administrative Buildings) subcategory and School buildings subcategory.

According to the analysis of the public building stock in Romania (from inventory of existing buildings owned and occupied by central administration and adding estimated building data from local public administration – mainly offices and schools), the biggest share, in terms of total floor area and primary energy consumption, is represented by office buildings (30% of total floor area and 36% of total primary energy consumption) and by educational buildings (56% of total floor area and 51% of total primary energy consumption).

#### Proposed classes for further analyses, Romania

Building category	Share of the total conditioned area, %	Specific primary energy consumption, kWh/m <sup>2</sup> year	CO2 emission equivalent, kg/m <sup>2</sup> .year	
Offices/Public administration	29,7	474	89,9	
Educational buildings	55,7	358	74,7	

One should notice that the largest percentage of the 'inventory of buildings heated and/or cooled useful surface of 500 square meters, owned and occupied by central government' (which does not include local administration buildings and most of the education buildings (from kindergarten to high schools and VET units), which are under the authority of regional/local scholar inspectorates and local councils responsibility) is occupied by office buildings.

Regarding the education buildings, which is the building category with the highest share in the full building stock in Romania (along public office/administration buildings), one should mention the lack of mechanical ventilation systems, which lead to inadequate ventilation in many classrooms (considered to be the main cause of students' performance reduction and health symptoms). Moreover, it is a usual practice in schools renovation to increase the air tightness of building envelope without installing controlled ventilation systems. This will be the focus of all packages of technical solutions which will be provided within the RePublic\_ZEB project.

One reference building has been selected for each of these building categories, taking into consideration the average characteristics (total floor area, shape, thermal characteristics, use and primary energy). One should note that the building stock data did not permit the detailed definition of a virtual building (average statistical characteristics), but facilitated the choice of existing buildings which are similar to the average performance of the considered building categories in the public building stock.

The two defined reference buildings are presented in Table RO 1 and Table RO 2 (in Appendix of this report), detailing the necessary data which would allow performing simulation of the energy consumption (geometrical, building energy usage, base heat supply etc.).

The selected buildings are similar to the ones included (for existing buildings) in the calculation of cost-optimal levels of minimum energy performance requirements for buildings and building elements and in the definition of the Plan to increase the number of buildings with nearly zero energy consumption. The consideration of these buildings for further analysis in RePublic\_ZEB project gives the opportunity to go further with more ambitious interventions on the existing situation and to compare and evaluate the results on national and European level. The plans for future work and main goals in the project were presented to the stakeholders on the Ministry of Regional Development and Public Administration (General Directorate for Regional Development and Infrastructure) within a first «one to one» meeting. In this context, it is considered that the implementation of planned programs for energy efficiency in buildings (e.g. cohesion funds) could be supported by the outputs of the cost-effective analysis of renovation measures which will be performed in the IEE RePublic\_ZEB project framework.

#### 2.8 Slovenia

The main criteria applied in the analysis of the Slovenian public building stock are:

- Total floor area,
- Total delivered energy,

- Primary energy,
- $\circ$  CO<sub>2</sub> emissions.

Although the Slovenian building stock is rather old, the county itself is rather young. In the past, no research has been done on non-residential building stock throughout the 24 years, which consequently means that much is unknown about the service building sector. The Slovenian authorities are therefore very interested in the deeper analyses from the RePublic\_ZEB project. The latest report on "Cost optimal methodology" offered only the first glance on the subject of reference office buildings. Thus, five categories have been chosen for the further work: office, kindergarten, schools, health care facility and social housing.



#### Figure SI 1: Age structure of the non-residential buildings (Register of Real Estates, 2014)

Recent analyses on the entire building stock showed that the chosen five categories represent the largest part of the heated non-residential buildings. Until this year, no platform has been yet established that would enable regular monitoring of building's energy consumption, e.g. public buildings. In 2015, such register is going to start operating and will enable regular monitoring of e.g. renovations and energy consumption of those buildings. For the purpose of this work, the energy consumption was observed in the register of calculated and measured EPCs. The later consists of older buildings, while new buildings in majority have a calculated EPC. Values of specific energy cannot be compared directly, since there are reasons for its differentiation. One of them is the use of the building, where different influence of the users of the building is included – "standard use of the building" on calculated EPC being the most basic. However, such an overview can show behaviour, the actual consumption and gaps for energy savings. Based on the following table it is able to conclude:

- $\circ~$  office buildings, social housing and health-care facilities are the ones, which consume the most energy,
- with respect to the represented total floor area, office buildings have the biggest potential for renovation and the biggest progress in total can be made,
- $\circ$  all included buildings have a major consumption of electric energy, which can be lowered with the use of RES technologies.

	Total	Total delivered energy			Primary	v energy	CO2 emission equivalent	
Building category	area*	Calculated Measured EPC		Calculated EPC	Measured EPC	Calculated EPC	Measured EPC	
	1000 m <sup>2</sup>	Total, kWh/m <sup>2</sup> year	Fuel, Electricity, kWh/m <sup>2</sup> year kWh/m <sup>2</sup> year		kWh/m <sup>2</sup> year	kWh/m <sup>2</sup> year	kg/m <sup>2</sup> year	kg/m <sup>2</sup> year
Offices/Public administration	1042	164	140	181	236	565	27	115
Educational buildings - kindergarten	319	116	114	127	144	383	35	77
Educational buildings - schools	1998	107	75	72	112	247	28	50
Health-care facilities	713	217	92	153	289	465	81	96
Social housing	942	131	230	138	162	559	44	111

Proposed classes for further analyses with indicators, Slovenia

\*corresponding to the 2012 data

Despite the fact, that a lot of work has already been done within national strategic documents, FP7 and IEE projects, the analysis of public buildings in Slovenia remains an area that should be given more attention and focus. The vast majority of analysis, concerning the energy efficiency of buildings, was made for office buildings only. Taking this into account, five different categories of public buildings were proposed for further analysis in the frame of RePublic\_ZEB project, in order to further extend the knowledge and behaviour of such buildings on several levels (energy consumption, thermal comfort, cost effective measures). Furthermore, it is essential to compare and evaluate the results on national and European level, as well as gain the knowledge and experiences from project partners. This approach gives more insight and confidence while treating nonresidential buildings, which are known by their diversity of architecture and use of the building. The plans for future work and main goals in the project were presented to the stakeholders on the Ministry for infrastructure (Head of Energy Directorate Division) and Ministry for Justice (Head of Directorate for Investments and Real Estate) on our first and second »one to one« meeting. The proposition was accepted with support, since many public buildings are going to be renovated in the future and the main focus in the next years is going to be renovation of buildings of the central government. In order for the authorities to award grants from e.g. cohesion funds, the authorities must be aware of cost effective measures, which the IEE RePublic\_ZEB project gives.

#### 2.9 Spain (Catalonia)

Based on the analysis of the building categories, two classes for further analysis are proposed:

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m <sup>2</sup> year	CO2 emission equivalent, kg/m <sup>2</sup> .year	
Offices/Public administration	15	99,2	n/a	
Hospitals	6	293	n/a	

In coordination with the Catalan Energy Agency (ICAEN), responsible of the Energy performance certificates, it has been decided to work with two reference buildings, one office building and one hospital building. The real buildings have been selected together with ICAEN, in the one-to-one meetings. The reason to select offices is that a considerable amount of buildings exists in this category and hospitals are very energy intensive. This selection of reference buildings will contribute to have a good overview of the public building stock and energy performance towards nZEB in Catalonia, together with the work carried by other IEE projects working in nZEB buildings, like ZEMEDS, focusing in schools and in STEP-2-SPORT, focusing in sport buildings.

#### 2.10 the former Yugoslav Republic of Macedonia

The decision of the proposed classes as referent classes included the relevant stakeholders. Their involvement was part of the one-to-one meetings held as part of the WP 5. The consulted stakeholders were the Energy Agency and the Ministry of Economy.

The public building stock data included several classes of buildings:

- o Residential
- Offices / Public administration
- Educational buildings, and
- Health-care facilities

During the meetings with the stakeholders, each class of building was discussed.

Residential public buildings are consisted of student housing. This class of building has small share in the total floor area of the buildings.

Offices and public administration buildings have similar share in the total floor area as the residential public buildings. The difference with this class of buildings is that the flow of people is greater. Many of the administrative offices have also service activities and the flow of people is significant in this case.

The educational buildings include kindergartens, schools and universities/ high schools. The educational buildings share in the total floor area is dominant. The flow of people is also bigger that the rest of the classes.

The health care facilities have specific energy consumption. Stability in the energy supply is also crucial due to the sensibility of the processes that take place in this kind of buildings. Further analysis would be necessary for implementing measures in this class of buildings.

The conclusion of the reference classes of buildings was that Offices / public administration and educational buildings will be considered. As factor for the decision, the share in the total floor area of the class of buildings and the flow of people had most influence.

Proposed classes	for further analyses	, the former Yı	ugoslav Repub	olic of Macedonia
		,		

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m <sup>2</sup> year	CO2 emission equivalent, kg/m <sup>2</sup> .year	
Offices / Public administration	5	241	n/a	
Educational buildings	67	224	n/a	

#### 2.11 United Kingdom

After a first analysis of the public building stock categories, we went through the process of selecting the building categories for the study. In the UK, educational and office buildings represent an important share of the total conditioned area as shown in D2.1. Moreover, they have high specific energy consumption due to their age and so offer significant opportunities for energy savings. As a consequence, we included these two categories in the study with two main subcategories of offices, with different characteristics which are representative of office types categorised in a best practice publication (ECON19) produced by the UK's Carbon Trust. The building types selected were also comparable to those used in the UK's EPBD cost optimal report for the Commission.

Once the categories were selected, we gathered information for one representative building for each category and completed the template accordingly. When information was missing, we either used the default data from the database from the UK's national calculation methodology for energy performance (SBEM) for the corresponding building type, or made reasonable assumptions. Specifically, we used the SBEM database for the following fields:

- Fraction of the window frame area
- Infiltration (occupancy and non-occupancy period)
- Lighting and appliances (occupancy patterns)
- Set-point temperatures
- Distribution efficiency for the heating system

We made assumptions in some cases:

- Number of holidays
- Emissivity and absorbance of walls

#### **Proposed classes for further analyses, United Kingdom**

Building category	Share of the total conditioned area, %	Specific final energy consumption, kWh/m <sup>2</sup> year	CO2 emission equivalent, kg/m <sup>2</sup> .year
Offices/Public administration (Victorian office – Type 1)	<ul><li>13 (office floor area as</li><li>% of the total public sector floor area)</li></ul>	302	87
Offices/Public administration (1960s office – Type 2)	<ul><li>13 (office floor area as</li><li>% of the total public sector floor area)</li></ul>	249	82

## **3** Selection of reference buildings

#### **3.1 Definition of data**

The reference building for a building category/Subcategory can be defined as a building with representative for the building category parameters as follows:

- Built-up/conditioned area;
- Building age;
- Construction materials and corresponding thermal properties of the building envelope;

- Occupancy schedule;
- Technical systems/installations for maintaining the built environment;
- Operational pattern;
- Energy carriers used for heating.

#### **3.2 Data collection**

All necessary data: geometrical, building energy usage, base heat supply regime (type of the heating system, energy resource etc.) etc., which would allow to perform simulation of the energy consumption, should be collected.

A template for reporting has been designed as shown in Table 1.

Building category					
Subcategory					
Conditioned area	m <sup>2</sup>	Based on internal dimensions, external dimensions or overall internal dimensions			
Conditioned volume	m <sup>3</sup>				
Climatic zone		Ref. number: Cit	y:		
Part 1: Building (Zone) geometry					
Walls, north	$m^2$	Total wall area excl. wind	lows and doors		
Walls, east	$m^2$	Total wall area excl. wind	lows and doors		
Walls, south	m <sup>2</sup>	Total wall area excl. wind	lows and doors		
Walls, west	$m^2$	Total wall area excl. windows and doors			
Windows, north	$m^2$	Window area incl. frames			
Windows, east	m <sup>2</sup>	Window area incl. frames			
Windows, south	m <sup>2</sup>	Window area incl. frames			
Windows, west	$m^2$	Window area incl. frames			
Roof	m <sup>2</sup>				
Floor	m <sup>2</sup>				
Part 2: Building (Zone) properties					
Uwalls	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014		
ΔUtb	W/m <sup>2</sup> K	Add on to U-wall to a thermal bridges	account for the effect of		
b(ground)	-	Adjustment factor b to the ground			
b(un-conditioned space)	-	Adjustment factor b to unconditioned space			
b(adjacent sunspace)	-	Adjustment factor b to adjacent sunspace			
b(adjacent building)	m <sup>2</sup>	Adjustment factor b to adjacent building			
Uwindows	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014		

Table 1: Template for reporting the reference building input data

fraction of the window frame area	%		
g(F)	-	Total solar energy trans external shading.	mittance for window incl.
Uroof	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014
Ufloor	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014
3	-	Emissivity for external of materials and surface)	walls (depending on type
α	-	Solar absorption for ext type of materials and sur	ernal walls (depending on face)
Infiltration, occupancy period	$h^{-1}$		
Infiltration, non occupancy	$h^{-1}$		
Thermal capacity	Wh/m <sup>2</sup> K		
Part 3: Internal gains and operation	al schedule		
Metabolic heat (occupants)	W/m <sup>2</sup>	Average metabolic heat period	during the operation
Latent metabolic heat	W/m <sup>2</sup>	For cooling calculations	S
Weekdays	h/day	No. of hours with the m weekday	etabolic heat for a normal
Saturdays	h/day		
Sundays	h/day		
Lighting for illumination	W/m <sup>2</sup>	Average lighting power period	during the operation
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Lighting, emergency/controls	W/m <sup>2</sup>	Average lighting power period	during the operation
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Appliances	W/m <sup>2</sup>	Average simultaneous p during the operation per	power from appliances riod
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Latent heat	W/m <sup>2</sup>	For cooling calculations	S
Weekdays	h/day		
Saturdays	h/day		

Sundays			ł	n/day	ay							
Part 4: Holiday	<u>'S</u>					<u></u>						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)												
Part 5: Heating mode												
		Set-p tempe	ooint rature		Duration							
Weekdays		°C			h/da	у	h/da	ay with s	set-point	temper	ature	
Saturdays		°C			h/da	у						
Sundays		°C			h/da	у						
Unoccupied period		°C										
Holidays		°C										
Part 6: Heating system												
Emission efficient	ncy				%							
Distribution efficient	ciency				%							
Automatic contro	ol				%							
Generation efficient	iency				%	%						
Energy source (f	uel, ene	ergy car	rier)		-							
Fans/pumps room	n units				W/m <sup>2</sup>							
Pumps heating s	ystem				W/m <sup>2</sup>							
Pumps pre-heating	ng venti	ilation			W/m <sup>2</sup>	2						
Part 7: Mechan	ical ve	entilati	on syste	em (hea	<u>ting mo</u>	<u>de)</u>						
			Supj temper	oly ature	Duration							
Weekday	/S		°C			h/d	ay	h	i/day wi (oc	th full v cupancy	entilatio / period)	n rate
Saturdays		(	°C			h/d	ay					
Sundays		(	°C		h/day							
Ventilation rate, occupancy period, m3/hm2				nm <sup>2</sup>								
Ventilation rate,	non-oc	cupancy	y, m³/hm	1 <sup>2</sup>								
Heat recovery ef	ficiency	y, %										
Emission efficiency, %												

Distribution efficiency	<i>i</i> , %				
Automatic control, %					
Generation efficiency,	, %				
Energy source (fuel, e	nergy carrier)				
Fans, occupancy period					
Fans, non-occupancy period, W/m <sup>2</sup>					
Part 8: Domestic ho	t water systen	<u>ns</u>			
Quantity			l/m²year		
Temperature difference	ce		°C		
Distribution efficiency	/		%		
Automatic control %			%		
Generation efficiency	%		%		
Energy source (fuel, e		-			
Pumps, DHW system		W/m <sup>2</sup>			
Part 9: Cooling mod			-		
	Set-poir temperat	nt ure		Ľ	Duration
Weekdays	°C		h/day	h	/day with set-point temperature
Saturdays	°C		h/day		
Sundays	°C		h/day		
Unoccupied period	°C				
Holidays	°C				
Part 10: Cooling sys	<u>tem</u>				
Emission efficiency			%		
Distribution efficiency	/		%		
Automatic control			%		
Generation efficiency			%		
Fans/pumps room unit	ts		W/m <sup>2</sup>		
Pumps cooling system	1		W/m <sup>2</sup>		
Part 11: Mechanica	l ventilation s	system (co	oling mode)		
	Sup tempe	ply rature	Duration		
Weekdays	°C		h/day		h/day with full ventilation rate (occupancy period)

Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupan	cy period, n	n³/hm²		
Ventilation rate, non-occu	upancy, m <sup>3</sup> /	hm²		
Heat recovery efficiency,	%			
Night – cooling, m <sup>3</sup> /hm <sup>2</sup>				
Free - cooling, m <sup>3</sup> /hm <sup>2</sup>				
Emission efficiency,%				
Distribution efficiency, %	, )			
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period,	W/m <sup>2</sup>			
Fans, non-occupancy per	iod, W/m <sup>2</sup>			
Fans, night cooling, W/m	2			
Fans, free-cooling, W/m <sup>2</sup>				
Part 12: Appliances no	t influenci	ing the the	rmal balance	
	/ simulta	Average aneous powe	er	Duration
Weekdays		W/m <sup>2</sup>	h/day	
Saturdays		W/m <sup>2</sup>	h/day	
Sundays		W/m <sup>2</sup>	h/day	

## 4 Conclusions

Deliverable (D2.2) aims at providing reliable information about the technical and exploitation characteristics of public buildings in the countries covered by the project, which will serve as a basis for the analyses connected with the *defining the cost optimal and low-risk technological* "packages of measures" for the refurbishment of the public buildings towards nZEB.

After taking consideration of the buildings characteristics that are important for their energy consumption, the ISO requirements and the experience of the project partners, the structure of the information has been presented in a series of tables:

- Building (Zone) geometry
- Building (Zone) properties
- Internal gains and operational schedule
- Holidays schedule
- Heating mode
- Mechanical ventilation system (heating mode)
- Domestic hot water system

- $\circ$  Cooling mode
- Cooling system
- Mechanical ventilation system (cooling mode)
- Appliances not influencing the thermal balance

Reference buildings, which represent the corresponding category/Subcategory, have been selected on the basis of the collected information and the classification of public buildings by categories, presented in D2.1.

The choice has been made taking into account the heated/conditioned areas and the specific energy consumption per unit of area.

Depending on the available information and the individual building performance, the choice the partners made was different: real or imaginary building, which performance reflects the character of the corresponding category.

Data gaps will be filled-in with default data.

Each country has applied the defined criteria in order to choose at least 2 reference buildings, for some of the partners their number is bigger – up to 4.

The most popular categories, for which reference buildings have been selected, are the offices (9) and the educational buildings (8).

The created reliable database of reference buildings, representing the specific features of the public building stock in the studied countries, after a simulation will allow to make a comparative analysis by countries, climate conditions and types of use.

# **Appendix - Country data**

#### BULGARIA

The main conclusions of the analysis of the four selected representative building categories are as follows:

#### I. Building category: Residential

#### Subcategory: Student housing

- $\circ$  The reference building should have built-up area between 5000 and 10000 m<sup>2</sup>,
- Construction materials concrete + masonry; thermal properties of the building envelope corresponding to the national norms of 1999,
- Occupancy schedule 24 h/day 7 days/week,
- Technical systems: central heating with two options:
  - a) based on light oil burning water heating boiler
  - b) based on district heating

#### Table BG1: Residential, Student housing

Building category	RESIDENTIAL					
Subcategory	STUDENT HOUSING					
Conditioned area	m <sup>2</sup>	8270 (Based or	n external dimensions)			
Conditioned volume	m <sup>3</sup>	22247 (net volume)				
		Ref. number: 7	City: Sofia			
Climatic zone		1	Varna			
Part 1: Building (Zone) geometry	<u>"</u>					
Walls, north	m <sup>2</sup>	382,04				
Walls, east	m <sup>2</sup>	1019,93				
Walls, south	$m^2$	358,49				
Walls, west	$m^2$	1077,69				
Windows, north	m <sup>2</sup>		36,94			
Windows, east	m <sup>2</sup>	494,60				
Windows, south	$m^2$		48,99			
Windows, west	m <sup>2</sup>		456,12			
Roof	m <sup>2</sup>		1628,37			
Floor	m <sup>2</sup>		1628,37			
Part 2: Building (Zone) properties						

Uwalls	W/m <sup>2</sup> K	Prior to investment 0,50	Requirement at 2014 0,35				
ΔUtb	W/m <sup>2</sup> K	Add on to U-wall to ad thermal bridges	ccount for the effect of				
b(ground)	-						
b(un-conditioned space)	-						
b(adjacent sunspace)	-						
b(adjacent building)	m <sup>2</sup>						
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,65	Requirement at 2014 1,7				
fraction of the window frame area	%	Taken into account	in Uwindows and g				
g(F)	-	0,5	58				
Uroof	W/m <sup>2</sup> K	Prior to investment 0,3	Requirement at 2014 0,28				
Ufloor	W/m <sup>2</sup> K	Prior to investment 0,2	Requirement at 2014 0,2				
3	-	0,9					
α	-	0,6					
Infiltration, occupancy period	$h^{-1}$	0,63					
Infiltration, non occupancy	$h^{-1}$	0,0	53				
Thermal capacity	Wh/m <sup>2</sup> K	45,	83				
Part 3: Internal gains and operation	nal schedule						
Metabolic heat (occupants)	W/m <sup>2</sup>	5,5	5				
Latent metabolic heat	W/m <sup>2</sup>	n/a	l				
Weekdays	h/day	24					
Saturdays	h/day	24					
Sundays	h/day	24					
Lighting for illumination	W/m <sup>2</sup>	3,2					
Weekdays	h/day	6					
Saturdays	h/day	6					
Sundays	h/day	6					
Lighting, emergency/controls	W/m <sup>2</sup>	n/a	l				
Weekdays	h/day						
Saturdays	h/day						
Sundays	h/day						
Appliances	W/m <sup>2</sup>	7,1	4				
Weekdays	h/day	24	·				
Saturdays	h/day	24					

Sundays					h/day	24						
Latent heat					W/m <sup>2</sup>			For co	oling cal	culation	S	
Weekdays					h/day							
Saturdays					h/day							
Sundays					h/day							
<u>Part 4: Holi</u>	<u>days</u>											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0
Part 5: Heat	ting ma	<u>ode</u>										
		Set temp	-point eratur	e				Durat	ion			
Weekdays		°C	2	1	h/day			24				
Saturdays		°C	2	1	h/	h/day			24			
Sundays		°C	2	1	h/	h/day				24		
Unoccupied period		°C	2	1								
Holidays		°C	2	1								
<u>Part 6: Heat</u>	ting sys	<u>stem</u>										
Emission eff	iciency				%			100				
Distribution	efficien	су			%			95				
Automatic co	ontrol				%				(	€7		
Generation e	fficienc	у			%				1	00		
Energy source	e (fuel,	energy o	carrier)		-				Distric	t heating	,	
Fans/pumps	room ur	nits			W/1	n²	_			0		
Pumps heatir	ng syste	m			W/1	m <sup>2</sup>	_		0	,25		
Pumps pre-he	eating v	entilatio	n		W/1	n²				0		
Part 7: Mec	<u>hanica</u>	l ventild	tion sy	stem (h	neating n	<u>node)</u>						
			Suj tempe	oply rature	•			Du	ration			
Weekdays			°C			h/	day			n/a		
Saturdays			°C			h/	day					
Sundays			°C			h/	day					

Ventilation rate, or	ccupancy period, m <sup>3</sup> /l	nm²	
Ventilation rate, no	on-occupancy, m <sup>3</sup> /hm	2	
Heat recovery effic	ciency, %		
Emission efficiency	y, %		
Distribution efficie	ency, %		
Automatic control,	%		
Generation efficier	ncy, %		
Energy source (fue	el, energy carrier)		
Fans, occupancy pe	eriod, W/m <sup>2</sup>		
Fans, non-occupan	cy period, W/m <sup>2</sup>		
Part 8: Domestic	hot water systems		
Quantity		l/m²year	1564
Temperature differ	rence	°C	30
Distribution efficie	ency	%	93
Automatic control	%	%	97
Generation efficier	ncy %	%	100
Energy source (fue	el, energy carrier)	-	District heating
Pumps, DHW syste	em	W/m <sup>2</sup>	0,1
Part 9: Cooling n	<u>node</u>		
	Set-point temperature		Duration
Weekdays	°C	h/day	n/a
Saturdays	°C	h/day	
Sundays	°C	h/day	
Unoccupied period	°C		
Holidays	°C		
Part 10: Cooling	system	I	
Emission efficienc	у	%	n/a
Distribution efficie	ency	%	
Automatic control		%	
Generation efficier	ncy	%	
Fans/pumps room	units	W/m <sup>2</sup>	
Pumps cooling sys	tem	W/m <sup>2</sup>	

Part 11: Mechanical	ventilation system (coolin	eg mode)					
	Supply temperature	Duration					
Weekdays	°C	h/day	n/a				
Saturdays	°C	h/day					
Sundays	°C	h/day					
Ventilation rate, occupa	ncy period, m <sup>3</sup> /hm <sup>2</sup>	<u>.</u>					
Ventilation rate, non-oc	cupancy, m <sup>3</sup> /hm <sup>2</sup>						
Heat recovery efficiency	y, %						
Night – cooling, m <sup>3</sup> /hm <sup>2</sup>	2						
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>							
Emission efficiency,%							
Distribution efficiency,	%						
Automatic control, %							
Generation efficiency, 9	6						
Fans, occupancy period	, W/m²						
Fans, non-occupancy pe	eriod, W/m <sup>2</sup>						
Fans, night cooling, W/	m <sup>2</sup>						
Fans, free-cooling, W/m	1 <sup>2</sup>						
Part 12: Appliances n	ot influencing the therm	al balance					
	Average simultaneous power	Duration					
Weekdays	W/m <sup>2</sup>	h/day	0				
Saturdays	W/m <sup>2</sup>	h/day	0				
Sundays	W/m <sup>2</sup>	h/day	0				

### II. Building category: Offices/Public administration Subcategory: Central authorities

- $\circ$  The reference building should have built-up area less than 5000 m<sup>2</sup>,
- Construction materials concrete + masonry; thermal properties of the building envelope corresponding to the national norms of 1999,
- $\circ$  Occupancy schedule 8 h/day 5 days/week,
- $\circ$   $\;$  Technical systems: central heating with two options:
  - a) based on light oil burning water heating boiler
  - b) based on district heating

#### Table BG2: Office/public administration, Central authorities – Administrative buildings

Building category		OFFICES/PUBLIC ADMINISTRAT				
Subcategory		Central authorities – Administrative Building				
Conditioned area	m <sup>2</sup>	1772 (extern	nal dimensions)			
Conditioned volume	m <sup>3</sup>	4252 (n	et volume)			
		Ref. number: 7	City: Sofia			
Climatic zone		1	Varna			
Part 1: Building (Zone) geometry		•				
Walls, north	m <sup>2</sup>	23	1,26			
Walls, east	m <sup>2</sup>	27	3,96			
Walls, south	m <sup>2</sup>	31	0,52			
Walls, south-west	m <sup>2</sup>	60	),88			
Walls, west	m <sup>2</sup>	16	6,33			
Walls, north-west	m <sup>2</sup>	4	7,0			
Windows, north	m <sup>2</sup>	1:	54,2			
Windows, east	m <sup>2</sup>	48,7				
Windows, south	m <sup>2</sup>	78,04				
Windows, west	m <sup>2</sup>	28,27				
Windows, north-west	m <sup>2</sup>	3	1,14			
Roof	m <sup>2</sup>	52	6,83			
Floor	m <sup>2</sup>	38	7,83			
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014			
Allth	$W/m^2 K$	0,5	0,55			
b(ground)	w/m K					
b(ground)						
b(adjacent sunspace)						
b(adjacent building)	m <sup>2</sup>					
Uwindows	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014			
fraction of the window frame area	%	taken into accoun	t in Uwindow and g			
g(F)	-	0	,56			
Uroof (to the external air)	W/m <sup>2</sup> K	Prior to investment 0,3	Requirement at 2014 0,28			
Ufloor (to the external air)	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014			

						0,2	2			0,2		
З				-				0,9				
α				-				0,6				
Infiltration, occupanc	y period			$h^{-1}$		0,7						
Infiltration, non occu	pancy			h <sup>-1</sup> 0,7								
Thermal capacity			W	h/m <sup>2</sup> K		45,83						
Part 3: Internal gai	ns and	operatio	onal sc	<u>hedule</u>								
Metabolic heat (occu	pants)			W/m <sup>2</sup>				6,3				
Latent metabolic heat				W/m <sup>2</sup>				0				
Weekdays				h/day				9				
Saturdays				h/day				0				
Sundays				h/day				0				
Lighting for illumind	tion			W/m <sup>2</sup>				4,1				
Weekdays				h/day				8				
Saturdays				h/day				0				
Sundays		h/day		0								
Lighting, emergency/controls				W/m <sup>2</sup>		0						
Weekdays	Weekdays					h/day						
Saturdays	ırdays				h/day							
Sundays				h/day								
Appliances				W/m <sup>2</sup>				8,8				
Weekdays				h/day		24						
Saturdays				h/day		24						
Sundays				h/day		24						
Latent heat				W/m <sup>2</sup>		0						
Weekdays				h/day								
Saturdays				h/day								
Sundays				h/day								
Part 4: Holidays			<u> </u>									
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
No. of holidays (excluding weekends) 3	0	1	0	3	0	0	0	3	0	1	3	
Part 5: Heating mo	<u>de</u>											
	Set	t-point					Dura	tion				

	temper	ature						
Weekdays	°C	20		h/day		8		
Saturdays	°C	15		h/day		24		
Sundays	°C	15		h/day		24		
Unoccupied period	°C	15						
Holidays	°C	15						
Part 6: Heating sys	<u>stem</u>							
Emission efficiency				%		100		
Distribution efficient	су			%		95		
Automatic control				%		97		
Generation efficiency	у			%		89		
Energy source (fuel,	energy carri	er)		-	Light o	il burning water heating boiler		
Fans/pumps room un	its			W/m <sup>2</sup>		0		
Pumps heating system	m			W/m <sup>2</sup>		0,58		
Pumps pre-heating v	entilation			W/m <sup>2</sup>		0		
Part 7: Mechanical ventilation system (heating mode)								
	te	Supply emperatu	ire		]	Duration		
Weekdays	°(		25	h/da	ıy	8		
Saturdays	°(	2		h/da	ıy			
Sundays	°(			h/da	ıy			
Ventilation rate, occu	upancy perio	d, m³/hm²	2	0,67				
Ventilation rate, non-	-occupancy,	m³/hm²		0				
Heat recovery efficie	ency, %			n/a				
Emission efficiency,	%					100		
Distribution efficient	су, %			100				
Automatic control, %	, D			97				
Generation efficiency	y, %					100		
Energy source (fuel,	energy carri	er)			]	Electricity		
Fans, occupancy peri	iod, W/m <sup>2</sup>					0,30		
Fans, non-occupancy	v period, W/	m²		0				
Part 8: Domestic h	ot water sy.	<u>stems</u>						
Quantity				l/m <sup>2</sup> year		107		
Temperature differen	nce			°C	°C 30			
Distribution efficient	cy			%		95		

Automatic control %					%	% 97				
Generation efficiency	%				%		89			
Energy source (fuel, e	nergy car	rier)			-	Light	oil burning water heating boiler			
Pumps, DHW system					W/m <sup>2</sup>		0			
Part 9: Cooling mod	<u>le</u>					<u>.</u>				
	Set temp	•point eratu	t re			iration				
Weekdays	°C	2	25		h/day		9			
Saturdays	°C	2	29		h/day		24			
Sundays	°C	2	29		h/day		24			
Unoccupied period	°C	2	29							
Holidays	°C	2	29							
Part 10: Cooling sys	<u>tem</u>									
Emission efficiency					%		100			
Distribution efficiency					%		100			
Automatic control					%		97			
Generation efficiency					%		250			
Fans/pumps room unit	ts				W/m <sup>2</sup>		0,2			
Pumps cooling system	1				W/m <sup>2</sup>		0,38			
Part 11: Mechanica	l ventilat	ion sy	vstem (	cool	ling mode)					
	Sup temp	ply peratur	re				Duration			
Weekdays	C	C	20		h/day	τ	9			
Saturdays	C	C			h/day	τ				
Sundays	C	С			h/day	7				
Ventilation rate, occup	pancy per	iod, m <sup>a</sup>	³/hm²				0,67			
Ventilation rate, non-o	occupancy	∕, m³/h	m²				0			
Heat recovery efficien	icy, %						n/a			
Night - cooling, m <sup>3</sup> /hi	m²				n/a					
Free – cooling, m <sup>3</sup> /hm	2						n/a			
Emission efficiency,%	)				100					
Distribution efficiency	/, %						100			
Automatic control, %					97					
Generation efficiency,	, %						250			
Fans, occupancy perio	od, $W/m^2$				0,3					

Fans, non-occupancy perio	od, W/m <sup>2</sup>	0					
Fans, night cooling, W/m <sup>2</sup>		n/a					
Fans, free-cooling, W/m <sup>2</sup>		n/a					
Part 12: Appliances not influencing the thermal balance							
	Average simultaneous power	Duration					
Weekdays	4,54 W/m <sup>2</sup>	h/day	24				
Saturdays	4,54 W/m <sup>2</sup>	h/day 24					
Sundays	4,54 W/m <sup>2</sup>	h/day	24				

#### **III.** Building category: Educational buildings

#### **Subcategory: Schools**

- $\circ$  The reference building should have built-up area less than 5000  $\text{m}^2,$
- Construction materials concrete + masonry; thermal properties of the building envelope corresponding to the national norms of 1999,
- Occupancy schedule:
  - a) 8 h/day 5 days/week,
  - b) 12 h/day 5 days/week.
- Technical systems: central heating with two options:
  - a) based on light oil burning water heating boiler
  - b) based on district heating.

#### Table BG3: Educational buildings, Schools

Building category		EDUCATIONAL BUILDINGS				
Subcategory		School				
Conditioned area	m <sup>2</sup>	3510 (external dimensions)				
Conditioned volume	m <sup>3</sup>	11583 (net volume)				
		Ref.number: 7 City: Sofia				
Climatic zone		1 Varna				
Part 1: Building (Zone) geometry						
Walls, north	m <sup>2</sup>	537				
Walls, east	m <sup>2</sup>	70				
Walls, south	m <sup>2</sup>	1260				
Walls, west	m <sup>2</sup>	93				
Windows, north	m <sup>2</sup>	230				
Windows, east	m <sup>2</sup>	30				
Windows, south	m <sup>2</sup>	540				

Windows, west	m <sup>2</sup>	40					
Roof	m <sup>2</sup>	10	)50				
Floor	m <sup>2</sup>	10	)50				
Part 2: Building (Zone) properties							
Uwalls	W/m <sup>2</sup> K	Prior to investment 0,50	Requirement at 2014 0,35				
ΔUtb	W/m <sup>2</sup> K		J <u> </u>				
b(ground)	-						
b(un-conditioned space)	-						
b(adjacent sunspace)	-						
b(adjacent building)	m <sup>2</sup>						
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,65	Requirement at 2014 1,7				
fraction of the window frame area	%	taken into account	in Uwindows and g				
g(F)	-	0,	56				
Uroof (to external air)	W/m <sup>2</sup> K	Prior to investment 0,3	Requirement at 2014 0,28				
Ufloor (to external air)	W/m <sup>2</sup> K	Prior to investment 0,2	Requirement at 2014 0,2				
3	-	0	,9				
α	-	0	,6				
Infiltration, occupancy period	h <sup>-1</sup>	0	),7				
Infiltration, non occupancy	$h^{-1}$	0	),7				
Thermal capacity	Wh/m <sup>2</sup> K	45	,83				
Part 3: Internal gains and operation	nal schedule						
Metabolic heat (occupants)	W/m <sup>2</sup>	6	5,9				
Latent metabolic heat	W/m <sup>2</sup>	r	n/a				
Weekdays	h/day	]	12				
Saturdays	h/day		0				
Sundays	h/day		0				
Lighting for illumination	W/m <sup>2</sup>	1	,7				
Weekdays	h/day		4				
Saturdays	h/day		0				
Sundays	h/day		0				
Lighting, emergency/controls	W/m <sup>2</sup>		0				
Weekdays	h/day						
Saturdays	h/day						

Sundays				1	n/day									
Appliances				V	W/m²		0,6							
Weekdays				1	n/day		12							
Saturdays				1	n/day		0							
Sundays				1	h/day					0				
Latent heat				<u> </u>	W/m <sup>2</sup>					n/a				
Weekdays				1	n/day									
Saturdays				1	n/day									
Sundays				1	n/day									
<u>Part 4: Holida</u>	<u>ays</u>													
	Jan	Feb	Mar	Apr	May	Jı	un	Jul	Aug	Sep	Oct	Nov	Dec	
No. of holidays (excluding weekends)	3	0	1	9	3	1	0	23	22	11	0	1	7	
Part 5: Heating mode														
		Set-j tempe	point rature					Duration						
Weekdays		°C	20		h/da	y	12							
Saturdays		°C	15		h/da	y		24						
Sundays		°C	15		h/da	y		24						
Unoccupied period		°C	15											
Holidays		°C	15											
Part 6: Heatin	ig syste	<u>em</u>												
Emission effici	ency				%		100							
Distribution eff	ficiency				%					ç	95			
Automatic cont	trol				%					ç	97			
Generation effi	ciency				%					8	39			
Energy source	(fuel, en	nergy ca	rrier)		-			Li	ght oil b	urning v	water he	ating bo	oiler	
Fans/pumps ro	om units	s			W/m	1 <sup>2</sup>								
Pumps heating	system				W/m	12				0	,2			
Pumps pre-hear	ting ven	tilation			W/m	12								
Part 7: Mecha	nical v	entilat	ion syst	em (he	ating m	ode	<u>e)</u>							
			Suppl	y	Duration									
	te	mperatui	·e											
---	-----------------	------------------	----------	-----------------------	--	-----	--	--						
Weekdays	°C			h/day		n/a								
Saturdays	°C	2		h/day										
Sundays	°C	1		h/day										
Ventilation rate, occupancy period, m <sup>3</sup> /hm <sup>2</sup>														
Ventilation rate, non-occupancy, m <sup>3</sup> /hm <sup>2</sup>														
Heat recovery efficie	ency, %													
Emission efficiency,	%													
Distribution efficient	су, %													
Automatic control, %	6													
Generation efficiency	y, %													
Energy source (fuel,	energy car	rier)												
Fans, occupancy per	iod, W/m²													
Fans, non-occupancy	y period, W	7/m <sup>2</sup>												
Part 8: Domestic h	ot water s	<u>ystems</u>												
Quantity			l/m²year		11									
Temperature difference			°C		30									
Distribution efficient	су			%		95								
Automatic control %	1			%		97								
Generation efficienc	у %			%		89								
Energy source (fuel,	energy car	rier)		-	- Light oil burning water heating boiler									
Pumps, DHW system	n			W/m <sup>2</sup> 0,15										
Part 9: Cooling mo	<u>ode</u>													
	Set-p temper	oint cature		Duration										
Weekdays	°C			h/day		n/a								
Saturdays	°C			h/day										
Sundays	°C			h/day										
Unoccupied period	°C													
Holidays	°C													
Part 10: Cooling sy	ystem_													
Emission efficiency				%		n/a								
Distribution efficient	cy			%										
Automatic control				%										

Generation efficiency			%				
Fans/pumps room units			W/m <sup>2</sup>				
Pumps cooling system			W/m <sup>2</sup>				
Part 11: Mechanical v	Part 11: Mechanical ventilation system (co						
	Supply temperature		Duration				
Weekdays	°C		h/da	чy	n/a		
Saturdays	°C		h/da	ıy			
Sundays	°C		h/da	ıy			
Ventilation rate, occupan	icy period, m	³/hm²					
Ventilation rate, non-occ	upancy, m <sup>3</sup> /h	1m <sup>2</sup>					
Heat recovery efficiency,	, %						
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>							
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>							
Emission efficiency,%							
Distribution efficiency, %	6						
Automatic control, %							
Generation efficiency, %							
Fans, occupancy period,	W/m <sup>2</sup>						
Fans, non-occupancy per	riod, W/m <sup>2</sup>						
Fans, night cooling, W/m	$l^2$						
Fans, free-cooling, W/m <sup>2</sup>	2						
Part 12: Appliances no	ot influenci	ng the the	rmal balance	<u> </u>			
Average simultaneous powe		rage ous power			Duration		
XXX 1 1	40.11	7/ 2	1 / 1				

Weekdays	$40 \text{ W/m}^2$	h/day	8
Saturdays	W/m <sup>2</sup>	h/day	
Sundays	W/m <sup>2</sup>	h/day	

# IV. Building category: Health-care facilities

# Subcategory: Hospitals

- $\circ$   $\,$  The reference building should have built-up area less than 5000 m2,
- Construction materials concrete + masonry; thermal properties of the building envelope corresponding to the national norms of 1999,
- Occupancy schedule: 24 h/day 7 days/week,
- Technical systems: central heating with two options:

- a) based on light oil burning water heating boiler
- b) based on district heating

#### Table BG4: Health-care facilities, Hospitals

Building category	HEALTH-CARE FACILITIES						
Subcategory		Hospital					
Conditioned area	$m^2$	2546 (externa	l dimensions)				
Conditioned volume	m <sup>3</sup>	8106 (net volume)					
<b>I</b>		Ref. number: 7	City: Sofia				
Climatic zone		1	Varna				
Part 1: Building (Zone) geometry		1					
Walls, north	m <sup>2</sup>	764	,26				
Walls, east	$m^2$	250,	,45				
Walls, south	$m^2$	560,	,47				
Walls, west	m <sup>2</sup>	25	1				
Windows, north	m <sup>2</sup>	207,	,76				
Windows, east	m <sup>2</sup>	37,69					
Windows, south	m <sup>2</sup>	367,55					
Windows, west	m <sup>2</sup>	43,42					
Roof	m <sup>2</sup>	106	57				
Floor	m <sup>2</sup>	1067					
Part 2: Building (Zone) properties							
Uwalls	W/m <sup>2</sup> K	Prior to investment 0,50	Requirement at 2014 0,35				
ΔUtb	W/m <sup>2</sup> K						
b(ground)	-						
b(un-conditioned space)	-						
b(adjacent sunspace)	-						
b(adjacent building)	m <sup>2</sup>						
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,65	Requirement at 2014 1,7				
fraction of the window frame area	%	taken into account	in Uwindows and g				
g(F)	-	0,	56				
Uroof (to external air)	W/m <sup>2</sup> K	Prior to investment 0,30 Requirement at 2 0,28					
Ufloor (to external air)	W/m <sup>2</sup> K	Prior to investment 0,2	Requirement at 2014 0,2				

3					-		0,9							
α					-			0,6						
Infiltration, occ	occupancy period				$h^{-1}$			0,7						
Infiltration, nor	1 occi	ipancy			$h^{-1}$		0,7							
Thermal capacity					Wh/m <sup>2</sup>	K				45,8	3			
Part 3: Intern	al ga	ins and a	peratio	nal so	al schedule									
Metabolic heat	t (occi	upants)			W/m <sup>2</sup>					5,4				
Latent metabol	lic he	at			W/m <sup>2</sup>					0				
Weekdays					h/day					24				
Saturdays					h/day					24				
Sundays					h/day					24				
Lighting for ill	lumin	ation			W/m <sup>2</sup>					4,1				
Weekdays					h/day					8,5				
Saturdays					h/day					8,5				
Sundays				h/day		8,5								
Lighting, emergency/controls			W/m <sup>2</sup>			0								
Weekdays					h/day									
Saturdays				h/day										
Sundays				h/day										
Appliances				W/m <sup>2</sup>			4							
Weekdays				h/day			7,5							
Saturdays				h/day				7,5						
Sundays				h/day			7,5							
Latent heat					W/m <sup>2</sup>		0							
Weekdays					h/day									
Saturdays					h/day									
Sundays					h/day									
Part 4: Holida	<u>iys</u>													
	Jar	n Feb	Mar	Apr	: May	y	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
No. of holidays (excluding weekends)	0	0	0	0 0		0	0	0	0	0	0	0		
Part 5: Heatin	ng ma	ode												
Set-point temperature					Duration									

Weekdays	°C	21	h/day	24			
Saturdays	°C	21	h/day	24			
Sundays	°C	21	h/day	24			
Unoccupied period	°C	21					
Holidays	°C	21					
Part 6: Heating sys	<u>stem</u>						
Emission efficiency			%	100			
Distribution efficien	су		%	95			
Automatic control			%	97			
Generation efficienc	y		%	89			
Energy source (fuel,	energy carri	er)	-	Light oil burning water heating boiler			
Fans/pumps room un	nits		W/m <sup>2</sup>				
Pumps heating syste	m		W/m <sup>2</sup>	2			
Pumps pre-heating v	entilation		W/m <sup>2</sup>	0,53			
Part 7: Mechanical ventilation system (heating mode)							
Supply temperature			Duration				
	tem	perature					
Weekdays	°C	perature 21	h/day	7,5			
Weekdays Saturdays	tem           °C           _°C	perature           21           21	h/day h/day	7,5 7,5			
Weekdays Saturdays Sundays	tem           °C          °C	perature           21           21           21           21	h/day h/day h/day	7,5 7,5 7,5 7,5			
Weekdays Saturdays Sundays Ventilation rate, occ	tem       °C       °C       °C       upancy period	perature           21           21           21           21           4, m³/hm²	h/day h/day h/day	7,5           7,5           7,5           2,5			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, non	tem °C °C °C upancy perio	perature           21           21           21           0, m³/hm²	h/day h/day h/day	7,5       7,5       7,5       2,5       0			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, non Heat recovery efficie	tem       °C       °C       upancy period       -occupancy,       ency, %	perature           21           21           21           4           21	h/day h/day h/day	7,5           7,5           7,5           7,5           2,5           0           n/a			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, non Heat recovery efficie Emission efficiency,	tem     °C     °C     °C     upancy period     i-occupancy,     ency, %     %	perature           21           21           21           d, m³/hm²           m³/hm²	h/day h/day h/day	7,5       7,5       7,5       7,5       2,5       0       n/a       100			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, non Heat recovery efficie Emission efficiency, Distribution efficien	tem       °C       °C       upancy period       -occupancy,       -occupancy,       ency, %       %       cy, %	perature           21           21           21           d, m³/hm²	h/day h/day h/day h/day	7,5       7,5       7,5       2,5       0       n/a       100       95			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, non Heat recovery efficie Emission efficiency, Distribution efficien Automatic control, 9	tem           °C           °C           °C           upancy period           -occupancy,	perature           21           21           21           0d, m³/hm²	h/day h/day h/day	7,5       7,5       7,5       2,5       0       n/a       100       95       97			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, non Heat recovery efficiency, Distribution efficiency, Distribution efficiency Automatic control, 9 Generation efficiency	tem           °C           °C           °C           upancy period           -occupancy,           -occupancy, %           %           cy, %           6           y, %	perature           21           21           21           0d, m³/hm²	h/day h/day h/day	7,5       7,5       7,5       2,5       0       n/a       100       95       97       100			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, occ Ventilation rate, non Heat recovery efficie Emission efficiency, Distribution efficien Automatic control, 9 Generation efficienc Energy source (fuel,	tem       °C       °C       °C       upancy period       -occupancy,       -ocupancy,       -occupancy, <td>perature           21           21           21           d, m³/hm²           m³/hm²           er)</td> <td>h/day h/day h/day</td> <td>7,5       7,5       7,5       2,5       0       n/a       100       95       97       100       Electricity</td>	perature           21           21           21           d, m³/hm²           m³/hm²           er)	h/day h/day h/day	7,5       7,5       7,5       2,5       0       n/a       100       95       97       100       Electricity			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, occ Ventilation rate, non Heat recovery efficien Emission efficiency, Distribution efficienc Automatic control, 9 Generation efficienc Energy source (fuel, Fans, occupancy per	tem°C°C°Cupancy periodin-occupancy,in-occupancy,in-occupancy,in-occupancy,ind,ww <td>perature         21         21         21         od, m³/hm²         m³/hm²         er)</td> <td>h/day h/day h/day h/day 1&lt;</td> <td>7,5       7,5       7,5       2,5       0       n/a       100       95       97       100       Electricity       2,2</td>	perature         21         21         21         od, m³/hm²         m³/hm²         er)	h/day h/day h/day h/day 1<	7,5       7,5       7,5       2,5       0       n/a       100       95       97       100       Electricity       2,2			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, occ Ventilation rate, non Heat recovery efficient Emission efficiency, Distribution efficient Automatic control, 9 Generation efficience Energy source (fuel, Fans, occupancy per Fans, non-occupancy	tem°C°C°Cupancy period-occupancy,-occ	perature         21         21         21         d, m³/hm²         m³/hm²         er)         n²	h/day h/day h/day h/day 1<	7,5           7,5           7,5           2,5           0           n/a           100           95           97           100           Electricity           2,2           0			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, occ Ventilation rate, non Heat recovery efficien Emission efficiency, Distribution efficienc Automatic control, 9 Generation efficienc Energy source (fuel, Fans, occupancy per Fans, non-occupancy	tem       °C       °C       °C       upancy period       ioccupancy,       ency, %       , %       cy, %       6       y, %       energy carrie       iod, W/m²       y period, W/m²	perature         21         21         21         0d, m³/hm²         m³/hm²         er)         n²         stems	h/day h/day h/day 	7,5       7,5       7,5       2,5       0       n/a       100       95       97       100       Electricity       2,2       0			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, occ Ventilation rate, non Heat recovery efficien Emission efficiency, Distribution efficienc Automatic control, 9 Generation efficienc Energy source (fuel, Fans, occupancy per Fans, non-occupancy <b>Part 8: Domestic h</b> Quantity	tem       °C       °C       °C       upancy period       i-occupancy,       i-occupancy,       ency, %       %       cy, %       %       y, %       energy carrier       iod, W/m²       y period, W/m²	perature         21         22         23         24         25         26         27	h/day h/day h/day h/day	7,5       7,5       7,5       2,5       0       n/a       100       95       97       100       Electricity       2,2       0       1702			
Weekdays Saturdays Sundays Ventilation rate, occ Ventilation rate, occ Ventilation rate, non Heat recovery efficien Emission efficiency, Distribution efficienc Automatic control, 9 Generation efficienc Energy source (fuel, Fans, occupancy per Fans, non-occupancy <b>Part 8: Domestic In</b> Quantity Temperature different	tem       °C       °C       °C       upancy period       ioccupancy,       ency, %       %       y, %       energy carrination       iod, W/m²       y period, W/m²       iot water sy	perature         21         21         21         21         d, m³/hm²         m³/hm²         er)         m²         stems	h/day h/day h/day h/day	7,5       7,5       7,5       2,5       0       n/a       100       95       97       100       Electricity       2,2       0       1702       30			

Automatic control %			0/		07			
Generation officiancy %				70		97 80		
Energy source (fuel, one		or)		70	Lig	07		
Pumps DHW system	ngy carri	ci)		W/m <sup>2</sup>				
Part Q. Casling and Is				**/111		0,15		
Fart 9: Cooling mode								
	Set-point temperature			Duration				
Weekdays	°C			h/day		n/a		
Saturdays	°C			h/day				
Sundays	°C			h/day				
Unoccupied period	°C							
Holidays	°C							
Part 10: Cooling syste	<u>em</u>							
Emission efficiency				%		n/a		
Distribution efficiency				%				
Automatic control				%				
Generation efficiency				%				
Fans/pumps room units				W/m <sup>2</sup>				
Pumps cooling system				W/m <sup>2</sup>				
Part 11: Mechanical v	v <mark>entilatio</mark>	on system	<u>n (coo</u>	<u>ling mode)</u>				
	Supply tempe	y rature		Duration				
Weekdays	°C			h/d	ay	n/a		
Saturdays	°C			h/d	ay			
Sundays	°C			h/d	ay			
Ventilation rate, occupa	ncy perio	d, m³/hm	1 <sup>2</sup>					
Ventilation rate, non-oc	cupancy,	m³/hm²						
Heat recovery efficiency	v, %							
Night - cooling, m3/hm2	2							
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>								
Emission efficiency,%								
Distribution efficiency,	%							
Automatic control, %								
Generation efficiency, %								

Fans, occupancy pe	eriod, W/m <sup>2</sup>				
Fans, non-occupane	cy period, W/m <sup>2</sup>				
Fans, night cooling	, W/m²				
Fans, free-cooling,	W/m <sup>2</sup>				
Part 12: Applianc	es not influencing the thern	<u>ial balance</u>			
	Average simultaneous power	Γ	Duration		
Weekdays	7,5 W/m <sup>2</sup>	h/day	8		
Saturdays	7,5 W/m <sup>2</sup>	h/day	8		
Sundays	7,5 W/m <sup>2</sup>	h/day 8			

# CROATIA

# I. Building category: Administrative buildings

### **Subcategory: Offices**

### Table HR1: Reference office building for continental climate

Building category		Office buildings				
Subcategory						
Conditioned area	m <sup>2</sup>	2677,37				
Conditioned volume	m <sup>3</sup>	803	32,11			
Climatic zone		Zagreb Maksimir				
Part 1: Building (Zone) geometry						
Walls, north	m <sup>2</sup>	380	59,60			
Walls, east	m <sup>2</sup>	-				
Walls, south	m <sup>2</sup>	1 <sup>2</sup> -				
Walls, west	m <sup>2</sup>	m <sup>2</sup> -				
Windows, north	m <sup>2</sup>	35	2,80			
Windows, east	m <sup>2</sup>	118,80				
Windows, south	m <sup>2</sup>	35	52,80			
Windows, west	m <sup>2</sup>	11	8,80			
Roof	m <sup>2</sup>	102	24,00			
Floor	m <sup>2</sup>	102	24,00			
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment 0,56 Requirement at 2014 0,45				

ΔUtb	W/m <sup>2</sup> K	0,10			
b(ground)	-	n/a – seasonal variation in calculation	of ground temperature used		
b(un-conditioned space)	-	1			
b(adjacent sunspace)	-	1			
b(adjacent building)	m <sup>2</sup>	1			
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,75	Requirement at 2014 1,80		
fraction of the window frame area	%	(	),30		
g(F)	-	0,60			
Uroof	W/m <sup>2</sup> K	Prior to investment 0,50	Requirement at 2014 0,30		
Ufloor	W/m <sup>2</sup> K	Prior to investment 0,52	Requirement at 2014 0,30		
3	-	Emissivity for external we materials and surface) n/a	valls (depending on type of		
α	-	Solar absorption for external walls (depending of type of materials and surface) n/a			
Infiltration, occupancy period	$h^{-1}$	0,70			
Infiltration, non occupancy	$\mathbf{h}^{-1}$	(	),20		
Thermal capacity	Wh/m <sup>2</sup> K	696	MJ/K		
Part 3: Internal gains and operatio	nal schedule				
Metabolic heat (occupants)	W/m <sup>2</sup>	Average metabolic ł p	eat during the operation eriod 6		
Latent metabolic heat	W/m <sup>2</sup>	For coolin	g calculations n/a		
Weekdays	h/day		13		
Saturdays	h/day		0		
Sundays	h/day		0		
Lighting for illumination	W/m <sup>2</sup>	Average lighting pop	wer during the operation eriod 9,72		
Weekdays	h/day				
Saturdays	h/day				
Sundays	h/day				

Lighting, emergency/controls			W	//m²	A	Average lighting power during the operation period n/a						
Weekdays	Weekdays				/day							
Saturdays				h/	/day							
Sundays	Sundays			h/	/day							
Appliances			W	//m²	Av	Average simultaneous power from appliances during the operation period n/a						
Weekdays				h/	/day							
Saturdays				h/	/day							
Sundays				h/	/day							
Latent heat				W	//m²			For coo	oling cal n/a	culation	IS	
Weekdays				h/	/day							
Saturdays				h/	/day							
Sundays			h/	/day								
Part 4: Holiday	<u>vs</u>											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0
Part 5: Heating	g mod	<u>e</u>			-		-					
		Set-p temper	oint ature			Duration						
Weekdays		°C	20		13 h/c	lay	h/da	ay with s	set-point	t temper	ature	
Saturdays		°C	20		0 h/d	ay						
Sundays		°C	20		0 h/d	ay						
Unoccupied period		°C	15									
Holidays		°C	15									
Part 6: Heating	g syste	<u>em</u>										
Emission efficie	ency				%		79,37					
Distribution effi	ciency				%		81,49					
Automatic contr	ol				%		<u> </u>		8	80		
Generation effic	iency				%			82,89				

Energy source (fuel,	energy carr	ier)	-		Natural gas			
Fans/pumps room un	its		W/m <sup>2</sup>		n/a			
Pumps heating syster	n		W/m <sup>2</sup>		n/a			
Pumps pre-heating ve	entilation		W/m <sup>2</sup>	W/m <sup>2</sup> n/a				
Part 7: Mechanical	Part 7: Mechanical ventilation system (heati							
	t	Supply emperatu	re	Duration				
Weekdays	°(	C	ł	n/day	h/day with full ventilation rate (occupancy period)			
Saturdays	°(	C	ł	/day				
Sundays	°(	C	ł	/day				
Ventilation rate, occu	ipancy peri	od, m³/hm²						
Ventilation rate, non-	-occupancy	, m³/hm²						
Heat recovery efficie	ncy, %							
Emission efficiency,	%							
Distribution efficience	cy, %							
Automatic control, %	)							
Generation efficiency	/, %							
Energy source (fuel,	energy carr	ier)						
Fans, occupancy peri	od, W/m²							
Fans, non-occupancy	period, W	<sup>/</sup> m <sup>2</sup>						
Part 8: Domestic he	ot water sy	<u>stems</u>						
Quantity			l/m²yea	r				
Temperature differen	ice		°C					
Distribution efficienc	сy		%					
Automatic control %			%					
Generation efficiency	/ %		%					
Energy source (fuel,	energy carr	ier)	-					
Pumps, DHW system	ı		W/m <sup>2</sup>					
Part 9: Cooling mo	<u>de</u>			<u> </u>	<u></u>			
	Set-j tempe	point rature			Duration			
Weekdays	°C	26	24 h/day		h/day with set-point temperature			
Saturdays	°C	26	0 h/day					

Sundays	°C	26	5	0 h/day						
Unoccupied period	°C		28							
Holidays	°C		28							
Part 10: Cooling sy	<u>stem</u>									
Emission efficiency				%		88,49				
Distribution efficienc	У			%		100				
Automatic control				%		0				
Generation efficiency	r			%		100				
Fans/pumps room uni	its			W/m <sup>2</sup>		n/a				
Pumps cooling system	n			W/m <sup>2</sup>		n/a				
Part 11: Mechanica	Part 11: Mechanical ventilation system (cooling mode)									
	Sup terr	oply operatur	re			Duration				
Weekdays		°C		h/day		h/day with full ventilation rate (occupancy period)				
Saturdays		°C		h/day						
Sundays <sup>°</sup> C				h/day						
Ventilation rate, occu	pancy p	eriod, 1	m³/hm²							
Ventilation rate, non-	occupai	ncy, m <sup>3</sup>	/hm²							
Heat recovery efficien	ncy, %									
Night - cooling, m <sup>3</sup> /h	m <sup>2</sup>									
Free – cooling, m <sup>3</sup> /hn	1 <sup>2</sup>									
Emission efficiency,%	6									
Distribution efficienc	y, %									
Automatic control, %										
Generation efficiency	, %									
Fans, occupancy period	od, W/n	12								
Fans, non-occupancy	period,	W/m <sup>2</sup>								
Fans, night cooling, V	W/m²									
Fans, free-cooling, W	//m²									
Part 12: Appliances	s not in	fluenc	ing the the	ermal balance						
	s	Av imultar	verage neous power	r		Duration				
Weekdays		V	W/m <sup>2</sup>	h/da	ıy					
Saturdays		١	W/m <sup>2</sup>	h/da	ıy					

Sundays W/m <sup>2</sup>	h/day	
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# II. Building category: Healthcare facilities

Subcategory:

# Table HR2: Reference health care building for continental climate

Building category		Healthcare facilities			
Subcategory					
Conditioned area	m <sup>2</sup>	2786,4			
Conditioned volume	m <sup>3</sup>	9473	3,76		
Climatic zone		Zagreb N	laksimir		
Part 1: Building (Zone) geometry	·				
Walls, north	m <sup>2</sup>	1025	5,61		
Walls, east	m <sup>2</sup>	-			
Walls, south	m <sup>2</sup>	-			
Walls, west	m <sup>2</sup>	-			
Windows, north	m <sup>2</sup>	19	4		
Windows, east	m <sup>2</sup>	52	2		
Windows, south	m <sup>2</sup>	204			
Windows, west	m <sup>2</sup>	60			
Roof	m <sup>2</sup>	2048,00			
Floor	m <sup>2</sup>	1591,00			
Part 2: Building (Zone) properties					
Uwalls	W/m <sup>2</sup> K	Prior to investment 0,99	Requirement at 2014 0,45		
ΔUtb	W/m <sup>2</sup> K	0,	10		
b(ground)	-	n/a – seasonal variation used in calculation	of ground temperature		
b(un-conditioned space)	-	]	l		
b(adjacent sunspace)	-				
b(adjacent building)	m <sup>2</sup>	1			
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,90	Requirement at 2014 1,80		
fraction of the window frame area	%	0,30			
g(F)	_	0,	60		
Uroof	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014		

		0,50	0,30			
Ufloor	W/m <sup>2</sup> K	Prior to investment 0,54	Requirement at 2014 0,30			
3	-	Emissivity for external of materials and surface	walls (depending on type) /a			
α	-	Solar absorption for external walls (depending of type of materials and surface)				
Infiltration, occupancy period	$h^{-1}$	1,00 (a	verage)			
Infiltration, non occupancy	$h^{-1}$	0,	20			
Thermal capacity	Wh/m <sup>2</sup> K	724,40	5 MJ/K			
Part 3: Internal gains and operation	nal schedule	-				
Metabolic heat (occupants)	W/m²	Average metabolic heat during the operation period 6				
Latent metabolic heat	W/m <sup>2</sup>	For cooling calculations n/a				
Weekdays	h/day	24				
Saturdays	h/day	24				
Sundays	h/day	24				
Lighting for illumination	W/m <sup>2</sup>	Average lighting pow pe	er during the operation riod 5,24			
Weekdays	h/day	24				
Saturdays	h/day	2	24			
Sundays	h/day	2	24			
Lighting, emergency/controls	W/m <sup>2</sup>	Average lighting pow pe	er during the operation riod 1/a			
Weekdays	h/day	2	24			
Saturdays	h/day	2	24			
Sundays	h/day	2	24			
Appliances	W/m <sup>2</sup>	Average simultaneous power from appliance during the operation period n/a				
Weekdays	h/day	2	24			
Saturdays	h/day		24			
Sundays	h/day	24				

Latent heat	nt heat W/m <sup>2</sup>			W/m <sup>2</sup>	For cooling calculations n/a							
Weekdays					h/day		24					
Saturdays					h/day			24				
Sundays					h/day				24			
Part 4: Holiday	<u>ys</u>											
	Jan	Feb	Mar	Ар	r May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0
Part 5: Heating	g mode	2										
		Set-p temper	oint ature					Duratio	on			
Weekdays		°C	22		24 h/c	lay		h/day w	ith set-j	point ter	nperatu	re
Saturdays		°C	22		24 h/o	lay						
Sundays		°C	22		24 h/	lay						
Unoccupied period		°C	15									
Holidays		°C	15									
Part 6: Heating	g syste	<u>m</u>										
Emission efficie	ncy				%				83,	,41		
Distribution efficiency					%				90,	,28		
Automatic contr	utomatic control								1(	)0		
Generation effic	iency				%				94	,31		
Energy source (1	fuel, en	ergy car	rier)		-				Natur	al gas		
Fans/pumps room	m units				W/m	2			n	/a		
Pumps heating s	ystem				W/m	2			n	/a		
Pumps pre-heati	ng ven	tilation			W/m	2			n/	/a		
Part 7: Mechai	nical v	<u>entilati</u>	on syst	<u>em (h</u>	eating m	<u>ode)</u>						
		te	Supp empera	ly nture				Dura	ation			
Weekdays		°	θ	e		h/da	у	h/	day wit	h full ve upancy	ntilatior period)	n rate
Saturdays		°C	θ	e		h/da	У					
Sundays		°(	θ	e		h/da	y					

Ventilation rate, occu	ipancy per	iod, m³/hm²		1500				
Ventilation rate, non-	occupanc	y, m³/hm²						
Heat recovery efficie	ncy, %			0,80				
Emission efficiency,	%			-				
Distribution efficience	y, %			-				
Automatic control, %	1			-				
Generation efficiency	7, %			-				
Energy source (fuel,	energy car	rier)		Electric energy				
Fans, occupancy peri	od, W/m²			n/a				
Fans, non-occupancy	period, W	7/m²		n/a				
Part 8: Domestic he	ot water s	<u>ystems</u>						
Quantity			l/m²year	392				
Temperature differen	ce		°C	45				
Distribution efficience	ÿ		%	59,47				
Automatic control %			%	-				
Generation efficiency	7 %		%	94,31				
Energy source (fuel,	energy car	rier)	-	Natural gas				
Pumps, DHW system	l		W/m <sup>2</sup>	-				
Part 9: Cooling mo	<u>de</u>							
	Set- temp	•point erature		Duration				
Weekdays	°C	26	24 h/day	h/day with set-point temperature				
Saturdays	°C	26	0 h/day					
Sundays	°C	26	0 h/day					
Unoccupied period	°C	28						
Holidays	°C	28	1					
Part 10: Cooling sy	<u>stem</u>	<u> </u>		<u></u>				
Emission efficiency			%	89,70				
Distribution efficienc	y		%	95,92				
Automatic control			%	0				
Generation efficiency	1		%	100				
Fans/pumps room un	its		W/m <sup>2</sup>	n/a				
Pumps cooling syster	n		W/m <sup>2</sup>	n/a				
Pumps cooling system     W/m²     n/a       Part 11: Mechanical ventilation system (cooling mode)     Image: Non-state state s								

	Supply temperatur	·e	Duration			
Weekdays	°C	θe	h/day	h/day with full ventilation rate (occupancy period)		
Saturdays	°C	θe	h/day			
Sundays	°C	θe	h/day			
Ventilation rate, occupancy period, m <sup>3</sup> /hm <sup>2</sup>				1500		
Ventilation rate, non-occ	supancy, m <sup>3</sup> /	′hm²		0		
Heat recovery efficiency	<sup>,</sup> %			80		
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>			0			
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>				0		
Emission efficiency,%						
Distribution efficiency,	%					
Automatic control, %						
Generation efficiency, %	)					
Fans, occupancy period,	W/m <sup>2</sup>					
Fans, non-occupancy per	riod, W/m <sup>2</sup>					
Fans, night cooling, W/n	n <sup>2</sup>					
Fans, free-cooling, W/m	2					
Part 12: Appliances no	ot influence	ing the the	ermal balance			
	Av	verage				

	Average simultaneous power	]	Duration
Weekdays	W/m <sup>2</sup>	h/day	
Saturdays	W/m <sup>2</sup>	h/day	
Sundays	W/m <sup>2</sup>	h/day	

# GREECE

# I. Building category: Offices/Public administration

# Subcategory: Central authorities

- The reference building should have built-up area between 1000 m2 and 1500 m2 for municipal buildings, and 10000 m2 for central administration buildings,
- Construction materials concrete +masonry; thermal properties of the building envelope before the 'Thermal Insulation Regulation' of 1979,
- $\circ \quad \mbox{Occupancy schedule} 10 \ \mbox{h/day 5 days/week,} \\$
- Technical systems: central heating with oil burning water heating boiler

 Table GR1: Offices/public administration, Central authorities – Administrative buildings

Building category		OFFICES/PUBLIC ADMINISTRATION				
Subcategory		Central authorities – Administrative Building				
Conditioned area	m <sup>2</sup>	5901 (external	l dimensions)			
Conditioned volume	m <sup>3</sup>	20228 (net	t volume)			
Climatic zone		Ref. number: (climatic	City: Athens, zone B)			
Part 1: Building (Zone) geometry						
Walls, north	m <sup>2</sup>	640	C			
Walls, east	m <sup>2</sup>	113	4			
Walls, south	m <sup>2</sup>	132	.7			
Walls, south-west	m <sup>2</sup>	-				
Walls, west	m <sup>2</sup>	945	5			
Walls, north-west	m <sup>2</sup>	-				
Windows, north	m <sup>2</sup>	170	)			
Windows, east	m <sup>2</sup>	189	9			
Windows, south	m <sup>2</sup>	367				
Windows, west	m <sup>2</sup>	110				
Windows, north-west	m <sup>2</sup>	-	-			
Roof	m <sup>2</sup>	887,	63			
Floor	m <sup>2</sup>	887,	63			
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment 2,2	Requirement at 2014 0,50			
ΔUtb	W/m <sup>2</sup> K					
b(ground)	-					
b(un-conditioned space)	-					
b(adjacent sunspace)	-					
b(adjacent building)	m <sup>2</sup>					
Uwindows	W/m <sup>2</sup> K	Prior to investment 5,70	Requirement at 2014 3,0			
fraction of the window frame area	%	taken into account i	in Uwindow and g			
g(F)	-	0,8	35			
Uroof (to the external air)	W/m <sup>2</sup> K	Prior to investment 3,05	Requirement at 2014 0,45			
Ufloor (to the external air)	W/m <sup>2</sup> K	Prior to investment 3,1 Requirement at 2014 0,50				
8	-	0,8				

					ir							
α				-			0,4					
Infiltration, occ	cupanc	y period		$h^{-1}$			0,44					
Infiltration, not	n occuj	pancy		$h^{-1}$				n/a				
Thermal capac	ity			Wh/	$m^2 K$				72,23	3		
Part 3: Interna	l gains	s and op	erationa	l sched	<u>lule</u>							
Metabolic hea	t (occi	ipants)		<b>W</b> /1	m <sup>2</sup>		8,0					
Latent metabo	<b>W</b> /1	m <sup>2</sup>				0						
Weekdays	h/d	ay				10						
Saturdays				h/d	ay				0			
Sundays				h/d	ay				0			
Lighting for il	lumin	ation		<b>W</b> /1	m <sup>2</sup>				16,0			
Weekdays				h/d	ay				8			
Saturdays				h/d	ay				0			
Sundays				h/d	ay				0			
Lighting, eme	rgency	/contro	s	<b>W</b> /1	m <sup>2</sup>		0					
Weekdays	h/d	h/day										
Saturdays				h/d	h/day							
Sundays				h/d	ay							
Appliances				<b>W</b> /1	m <sup>2</sup>		15,0					
Weekdays				h/d	ay		10					
Saturdays				h/d	ay		0					
Sundays				h/d	ay		0					
Latent heat				<b>W</b> /1	m <sup>2</sup>		0					
Weekdays				h/d	ay							
Saturdays				h/d	ay							
Sundays				h/d	ay							
Part 4: Holiday	<u>vs</u>											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	2	2	1	1	0	1	0	1	0	2
Part 5: Heating	g mode											
		Set-poi temper	nt ature		Duration							
Weekdays		°C	20		h/day 10							

Saturdays	°C		off	h/da	y				
Sundays	°C		off	h/da	y	<u> </u>			
Unoccupied period	°C		off		<u> </u>				
Holidays	°C		off						
Part 6: Heating system					<u></u>				
Emission efficiency				%			93		
Distribution efficienc	у			%			95		
Automatic control				%			n/a		
Generation efficiency	r			%			89		
Energy source (fuel, e	energy	carrie	;)	-		Oil bu	rning water heating boiler		
Fans/pumps room uni	its			W/m <sup>2</sup>			0		
Pumps heating system	n			W/m <sup>2</sup>			1,05 kW		
Pumps pre-heating ve	ntilat	ion		W/m <sup>2</sup>			0		
Part 7: Mechanical ventilation system (heating mode)									
	Supply				Duration				
Weekdays		°C	20		h/da	ay	10		
Saturdays		°C	<u>_</u>		h/da	ay			
Sundays		°C			h/day				
Ventilation rate, occu	pancy	period	, m³/hm²		3,00				
Ventilation rate, non-	occup	ancy, n	n³/hm²		0				
Heat recovery efficient	ncy, %	6			n/a				
Emission efficiency,	%				100				
Distribution efficienc	y, %				100				
Automatic control, %							n/a		
Generation efficiency	, %					2,2	20 (COP)		
Energy source (fuel, e	energy	y carrie	r)			El	lectricity		
Fans, occupancy peri-	od, W	/m²					5		
Fans, non-occupancy	perio	d, W/m	2				0		
Part 8: Domestic hot	water	<u>system</u>	<u>s</u>						
Quantity					l/m²year n/a		n/a		
Temperature differen	ce				°C				
Distribution efficienc	у				%				
Automatic control %					%				
Generation efficiency %				%					

Energy source (fuel, energy carrier)						-			
Pumps, DHW system	1					W/m <sup>2</sup>			
Part 9: Cooling mode	Part 9: Cooling mode								
	Set- tem	point peratu	re	Du	Duration				
Weekdays	°C		26	h/d	lay	ý		10	
Saturdays	°C		off	h/d	lay	ý			
Sundays	°C		off	h/d	lay	ý			
Unoccupied period	°C		off						
Holidays	°C		off						
Part 10: Cooling syst	em								
Emission efficiency				%				93	
Distribution efficience	сy			%				100	
Automatic control				%				n/a	
Generation efficiency %						1,50 (COP)			
Fans/pumps room units W					m²	2		n/a	
Pumps cooling system W/n					n²	2		n/a	
Part 11: Mechanical ventilation system (cooling				(cooling	n	<u>10de)</u>			
		Supp temp	ly erature			Duration			
Weekdays		°C	r	n/a		h/day			
Saturdays		°C				h/day			
Sundays		°C				h/day			
Ventilation rate, occu	ipanc	y perio	d, m³/h	m <sup>2</sup>				n/a	
Ventilation rate, non-	-occuj	pancy,	m³/hm²	2		0			
Heat recovery efficie	ncy, 9	6				n/a			
Night - cooling, m <sup>3</sup> /h	nm²					n/a			
Free – cooling, m <sup>3</sup> /hr	n²							n/a	
Emission efficiency,	%							n/a	
Distribution efficience	су, %					n/a			
Automatic control, %	)					n/a			
Generation efficiency	/, %							n/a	
Fans, occupancy peri	od, W	7/m²						n/a	
Fans, non-occupancy	peric	d, W/1	m²					n/a	
Fans, night cooling, V	W/m <sup>2</sup>							n/a	
Fans, free-cooling, W/m <sup>2</sup>						n/a			

Part 12: Appliances not influencing the thermal balance								
	Average simultaneous power	Duration						
Weekdays	4,5 W/m <sup>2</sup>	h/day	24					
Saturdays	4,5 W/m <sup>2</sup>	h/day	24					
Sundays	4,5 W/m <sup>2</sup>	h/day	24					

### **II.** Building category: Educational buildings

#### **Subcategory: Schools**

- The reference building should have built-up area less than 2000 m2,
- Construction materials concrete+masonry; thermal properties of the building envelope before the 'Thermal Insulation Regulation' of 1979,
- Occupancy schedule 8 h/day 5 days/week, 9 months (September May) for primary and secondary schools
- Technical systems: central heating with oil burning water heating boiler

#### Table GR2: Educational buildings, Schools

Building category		EDUCATIONAL BUILDINGS				
Subcategory		School				
Conditioned area	m <sup>2</sup>	1785,8 (external dimensions)				
Conditioned volume	m <sup>3</sup>	6247,6 (net volume)				
Climatic zone		Ref.number: 1 City:	Athens (climatic zone B)			
Part 1: Building (Zone) geometry						
Walls, northeast	m <sup>2</sup>	2	03			
Walls, southeast	$m^2$	165				
Walls, southwest	m <sup>2</sup>	212				
Walls, northwest	m <sup>2</sup>	161				
Windows, northeast	m <sup>2</sup>	130				
Windows, southeast	m <sup>2</sup>	19				
Windows, southwest	m <sup>2</sup>	1	36			
Windows, northwest	m <sup>2</sup>		25			
Roof	m <sup>2</sup>	5	91			
Floor	m <sup>2</sup>	591				
Part 2: Building (Zone) properties						
Uwalls	W/m²KPrior to investment 0,81Requirement a 0,50					

ΔUtb	W/m <sup>2</sup> K						
b(ground)	-						
b(un-conditioned space)	-						
b(adjacent sunspace)	-						
b(adjacent building)	m <sup>2</sup>						
Uwindows	W/m <sup>2</sup> K	Prior to investment 5,70	Requirement at 2014 3,0				
fraction of the window frame area	%	taken into account	in Uwindows and g				
g(F)	-	0,	85				
Uroof (to external air)	W/m <sup>2</sup> K	Prior to investment 4,18	Requirement at 2014 0,45				
Ufloor (to external air)	W/m <sup>2</sup> K	Requirement at 2014 0,50					
3	-	0	,8				
α	-	0	,4				
Infiltration, occupancy period	$\mathbf{h}^{-1}$	0,43					
Infiltration, non occupancy	$\mathbf{h}^{-1}$	n/a					
Thermal capacity	Wh/m <sup>2</sup> K	72,23					
Part 3: Internal gains and operational	<u>schedule</u>						
Metabolic heat (occupants)	W/m <sup>2</sup>	40	0,0				
Latent metabolic heat	W/m <sup>2</sup>	n	/a				
Weekdays	h/day		8				
Saturdays	h/day		0				
Sundays	h/day		0				
Lighting for illumination	W/m <sup>2</sup>	9	,6				
Weekdays	h/day		8				
Saturdays	h/day		0				
Sundays	h/day		0				
Lighting, emergency/controls	W/m <sup>2</sup>		0				
Weekdays	h/day						
Saturdays	h/day						
Sundays	h/day						
Appliances	W/m <sup>2</sup>		5				
Weekdays	h/day		8				
Saturdays	h/day		0				
Sundays	h/day		0				
Latent heat	W/m <sup>2</sup>	n	/a				

Weekdays				h/	h/day									
Saturdays				h/	h/day									
Sundays				h/	h/day									
Part 4: Holida	<u>ys</u>													
	Jan	Feb	Mar	Ap	r	May	J	un	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	5	0	2	10		2	7	,	23	21	8	1	1	6
Part 5: Heatin	g mode	<u>?</u>												
	1	Set-point temperati	ure		Du	iration								
Weekdays		°C	20		h/c	lay						8		
Saturdays	•	°C	off		h/c	lay								
Sundays		°C	off		h/c	lay								
Unoccupied period		ЪС	off											
Holidays		°C	off											
Part 6: Heatin	g syste	<u>m</u>												
Emission effic	iency				%	6 93								
Distribution ef	ficienc	y			%	% 93,5								
Automatic con	ıtrol				%	% n/a								
Generation eff	ïciency	7			%	% 89								
Energy source	(fuel,	energy ca	rrier)		-	Oil burning water heating boiler					r			
Fans/pumps ro	om un	its			W/	/m²			0					
Pumps heating	g syster	n			W/	/m²						5		
Pumps pre-hea	ating ve	entilation			W/	m²								
<u>Part 7: Mecha</u>	nical v	entilation	<u>ı system</u>	(he	atin,	<u>g mode)</u>	<u>)</u>							
		Sup tem	ply perature	e Durat			tio	n						
Weekdays		°C				h/da	y					n/a		
Saturdays		°C				h/da	y							
Sundays		°C				h/da	y							
Ventilation rat	e, occu	pancy pe	eriod, m <sup>2</sup>	/hm <sup>2</sup>	2									
Ventilation rat	e, non-	occupan	ey, m³/h	m²										
Heat recovery efficiency, %														

	0/		1			
Emission efficiency, %						
Distribution efficiency, %						
Automatic control,	%					
Generation efficient	су, %	• .				
Energy source (fuel	, energ	gy carrier)				
Fans, occupancy per	riod, V	W/m <sup>2</sup>				
Fans, non-occupanc	y peri	od, W/m <sup>2</sup>				
Part 8: Domestic ho	ot wate	e <u>r systems</u>				
Quantity				l/m²year		n/a
Temperature differe	ence			°C		
Distribution efficier	ncy			%		
Automatic control %	6			%		
Generation efficient	cy %			%		
Energy source (fuel	, energ	gy carrier)		-		
Pumps, DHW system				W/m <sup>2</sup>		
Part 9: Cooling mode						
	Set-p temp	point perature	Durat	ion		
Weekdays	°C	26	h/day			8
Saturdays	°C	off	h/day			
Sundays	°C	off	h/day			
Unoccupied period	°C	off				
Holidays	°C	off				
Part 10: Cooling sys	stem	<u>.</u>	_1		-1	
Emission efficiency	r		%			100
Distribution efficier	ncy		%			95
Automatic control			%			n/a
Generation efficient	су		%			2,80 (EER)
Fans/pumps room u	nits		W/m <sup>2</sup>	2		n/a
Pumps cooling system W/m			W/m <sup>2</sup>			n/a
Part 11: Mechanical ventilation system (cooling				mode)		
		Supply temperature		Duration		
Weekdays		°C		h/dav		n/a

Saturdays	°C	h/day	
Sundays	°C	h/day	
Ventilation rate, occupance	zy period, m <sup>3</sup> /hm <sup>2</sup>		·
Ventilation rate, non-occu	pancy, m <sup>3</sup> /hm <sup>2</sup>		
Heat recovery efficiency,	%		
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>			
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>			
Emission efficiency,%			
Distribution efficiency, %			
Automatic control, %			
Generation efficiency, %			
Fans, occupancy period, V	V/m <sup>2</sup>		
Fans, non-occupancy perio	od, W/m²		
Fans, night cooling, W/m <sup>2</sup>			
Fans, free-cooling, W/m <sup>2</sup>			
Part 12: Appliances not in	Ifluencing the therma	l balance	
	Average simultaneous power	Duration	
Weekdays	0,75 W/m <sup>2</sup>	h/day	24
Saturdays	0,75 W/m <sup>2</sup>	h/day	24
Sundays	0,75 W/m <sup>2</sup>	h/day	24

# HUNGARY

### I. Building category: Health-care facilities

#### Subcategory: Other institutional care buildings

- The reference building should have built-up area less than 5000 m2,
- Construction materials precast reinforced concrete unit
- Occupancy schedule: 12 h/day 5 days/week,
- Technical systems: central heating based on district heating

#### Table HU1: Health-care facilities, Other institutional care buildings

Building category		HEALTH-CARE FACILITIES				
Subcategory	Other institutional care buildings					
Conditioned area	m <sup>2</sup>	3560				
Conditioned volume	m <sup>3</sup>	9968				
Climatic zone	1	City: Győr				

Part 1: Building (Zone) geometry						
Walls, north-east	m <sup>2</sup>	2	10,6			
Walls, south-east	m <sup>2</sup>	4	77,5			
Walls, south-west	m <sup>2</sup>	2	10,6			
Walls, north-west	m <sup>2</sup>	4	79,2			
Windows, north-east	m <sup>2</sup>	1	49,9			
Windows, south-east	m <sup>2</sup>	1	57,6			
Windows, south-west	m <sup>2</sup>		0			
Windows, north-west	m <sup>2</sup>	1	55,8			
Roof	m <sup>2</sup>	1	129			
Floor	m <sup>2</sup>	12	209,6			
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,7	Requirement at 2014 0,45			
ΔUtb	W/m <sup>2</sup> K	Add on to U-wall to account for the effect of thermal bridges				
b(ground)	-					
b(un-conditioned space)	-					
b(adjacent sunspace)	-					
b(adjacent building)	$m^2$					
Uwindows	W/m <sup>2</sup> K	Prior to investment 1,2	Requirement at 2014 1,6			
fraction of the window frame area	%	Taken into acco	unt in Uwindows			
g(F)	-	0,	783			
Uroof	W/m <sup>2</sup> K	Prior to investment 0,8	Requirement at 2014 0,25			
Ufloor	W/m <sup>2</sup> K	Prior to investment 0,6	Requirement at 2014 0,5			
3	-	0	,75			
α	-	C	),6			
Infiltration, occupancy period	h <sup>-1</sup>	0	),5			
Infiltration, non occupancy	$h^{-1}$	0,5				
Thermal capacity	Wh/m <sup>2</sup> K	113,8				
Part 3: Internal gains and operation	nal schedule					
Metabolic heat (occupants)	W/m <sup>2</sup>		5			
Latent metabolic heat	W/m <sup>2</sup>	n/a				

Weekdays				ł	h/day 12							
Saturdays				ł	n/day		0					
Sundays				ł	h/day		0					
Lighting for illu	umin	tion		V	W/m <sup>2</sup>				5,5			
Weekdays				ł	n/day				12			
Saturdays				ł	n/day				0			
Sundays				ł	n/day				0			
Lighting, emerg	gency	/controls		V	W/m²	_			n/a			
Weekdays				ł	n/day							
Saturdays				ł	n/day							
Sundays				ł	n/day							
Appliances				V	W/m²				11			
Weekdays				ł	n/day				12			
Saturdays				ł	n/day				0			
Sundays				ł	n/day				0			
Latent heat			V	W/m <sup>2</sup>		n/a						
Weekdays			ł	h/day								
Saturdays				ł	h/day							
Sundays				ł	h/day							
Part 4: Holida	ys											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	0	1	2	0	0	1	0	1	0	3
Part 5: Heatin	g mo	<u>de</u>										
		Set-p tempe	point rature					Durat	ion			
Weekdays		°C	22		h/da	ay				12		
Saturdays		°C	19		h/da	ay				24		
Sundays		°C	19		h/da	ay				24		
Unoccupied period		°C	19									
Holidays		°C	18									
Part 6: Heatin	g sys	tem										
Emission efficie	ency				% 100							

Distribution efficiency	%	97			
Automatic control	%	92			
Generation efficiency	%	99			
Energy source (fuel, energy carrier)	-	District heating			
Fans/pumps room units	W/m <sup>2</sup>	0			
Pumps heating system	W/m <sup>2</sup>	0.05			
Pumps pre-heating ventilation	W/m <sup>2</sup>	0			

Part 7: Mechanical ventilation system (heating mode)

	Su tempo	pply erature		Duration	
Weekdays	°C		h/day		n/a
Saturdays	°C		h/day		
Sundays	°C		h/day		
Ventilation rate, occupa	ncy period, r	m³/hm²			
Ventilation rate, non-oc	cupancy, m <sup>3</sup> /	'nm²			
Heat recovery efficienc	y, %				
Emission efficiency, %					
Distribution efficiency,	%				
Automatic control, %					
Generation efficiency,	%				
Energy source (fuel, en	ergy carrier)				
Fans, occupancy period	, W/m²				
Fans, non-occupancy pe	eriod, W/m <sup>2</sup>				
Part 8: Domestic hot	water system	ns			
Quantity			l/m²year 1910		1910
Temperature difference			°C		35
Distribution efficiency			%		88
Automatic control %			%		93
Generation efficiency %	, D		%		88
Energy source (fuel, en	ergy carrier)		- District heating		
Pumps, DHW system			W/m <sup>2</sup>		0.03
Part 9: Cooling mode					
	Set-point temperatu	re		Du	ration

Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Unoccupied period	°C			
Holidays	°C			
Part 10: Cooling syste	<u>em</u>			
Emission efficiency			%	
Distribution efficiency			%	
Automatic control			%	
Generation efficiency			%	
Fans/pumps room units			W/m <sup>2</sup>	
Pumps cooling system			W/m <sup>2</sup>	
Part 11: Mechanical ventilation system			ooling mode)	
	Supply temperature	·e		Duration
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupa	ncy period,	m <sup>3</sup> /hm <sup>2</sup>		
Ventilation rate, non-oc	cupancy, m	³/hm²		
Heat recovery efficiency	y, %			
Night – cooling, m <sup>3</sup> /hm <sup>2</sup>	2			
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>				
Emission efficiency,%				
Distribution efficiency,	%			
Automatic control, %				
Generation efficiency, 9	6			
Fans, occupancy period	, W/m²			
Fans, non-occupancy pe	eriod, W/m <sup>2</sup>			
Fans, night cooling, W/m <sup>2</sup>				
Fans, free-cooling, W/m <sup>2</sup>				
Part 12: Appliances n	ot influend	cing the th	ermal balance	
	A simulta	verage neous powe	er	

		Duration					
Weekdays	W/m <sup>2</sup>	h/day	0				
Saturdays	W/m <sup>2</sup>	h/day	0				
Sundays	W/m <sup>2</sup>	h/day	0				

#### II. Building category: Offices/Public administration

#### Subcategory: Central authorities

- The reference building should have built-up area less than 5000 m2,
- Construction materials masonry,
- $\circ$  Occupancy schedule 8 h/day 5 days/week,
- Technical systems:
- o central heating based on gas burning water heating boiler
- DHW: electricity based water heating boiler

#### Table HU2: Office/public administration, Central authorities – Administrative buildings

Building category		OFFICES/PUBLIC ADMINISTRATION					
Subcategory		Central authorities – Administrative Building					
Conditioned area	$m^2$	15	59				
Conditioned volume	m <sup>3</sup>	46	77				
Climatic zone		City: Na	agyatád				
Part 1: Building (Zone) geometry							
Walls, north	m <sup>2</sup>	224,9					
Walls, east	m <sup>2</sup>	124,7					
Walls, south	m <sup>2</sup>	199,1					
Walls, west	m <sup>2</sup>	123,5					
Windows, north	m <sup>2</sup>	153	3,1				
Windows, east	m <sup>2</sup>	11	7,3				
Windows, south	m <sup>2</sup>	199	9,9				
Windows, west	m <sup>2</sup>	119	9,5				
Roof	m2	83	35				
Floor	m2	835					
Part 2: Building (Zone) properties							
Uwalls	W/m <sup>2</sup> K	Prior to investment Requirement at 20 0,84 0,45					
ΔUtb	W/m <sup>2</sup> K	Add on to U-wall to account for the effect of thermal bridges					

b(ground)	-					
b(un-conditioned space)	-					
b(adjacent sunspace)	-					
b(adjacent building)	$m^2$					
Uwindows	W/m <sup>2</sup> K	Prior to investment 3,2	Requirement at 2014 1,6			
fraction of the window frame area	%	Taken into acco	unt in Uwindows			
g(F)	-	0,783				
Uroof	W/m <sup>2</sup> K	Prior to investment 3,17 Requirement 0,25				
Ufloor	W/m <sup>2</sup> K	Prior to investment 2,71	Requirement at 2014 0,5			
3	-	0,	75			
α	-	0	,6			
Infiltration, occupancy period	$\mathbf{h}^{-1}$	0	,8			
Infiltration, non occupancy	$\mathbf{h}^{-1}$	0,8				
Thermal capacity	Wh/m <sup>2</sup> K	3,8				
Part 3: Internal gains and operational schedule						
Metabolic heat (occupants)	W/m <sup>2</sup>		7			
Latent metabolic heat	W/m <sup>2</sup>	n/a				
Weekdays	h/day	8				
Saturdays	h/day		0			
Sundays	h/day		0			
Lighting for illumination	W/m <sup>2</sup>	-	5,5			
Weekdays	h/day		8			
Saturdays	h/day		0			
Sundays	h/day		0			
Lighting, emergency/controls	W/m <sup>2</sup>	r	n/a			
Weekdays	h/day					
Saturdays	h/day					
Sundays	h/day					
Appliances	W/m <sup>2</sup>		9			
Weekdays	h/day	8				
Saturdays	h/day	0				
Sundays	h/day	0				
Latent heat	W/m <sup>2</sup>	r	n/a			
Weekdays	h/day					

Saturdays	h/day											
Sundays				h/e	day							
Part 4: Holidays	<u>s</u>											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	D ec
No. of holidays (excluding weekends)	2	0	0	1	2	0	0	1	0	1	0	3
Part 5: Heatin												
Set-point temperature				Duration								
Weekdays		°C	21		h/da	ay				8		
Saturdays		°C	18		h/da	ay			2	24		
Sundays		°C	18		h/da	ay			2	24		
Unoccupied perio	od	°C	18									
Holidays		°C	18									
Part 6: Heating system												
Emission efficien	су				% 100							
Distribution effic	iency				% 99							
Automatic contro	1				% 96,1							
Generation efficie	ency				%			87				
Energy source (fu	iel, ene	rgy carri	er)	-				gas				
Fans/pumps room	n units			W/m <sup>2</sup>				0				
Pumps heating sy	stem				W/m <sup>2</sup>			0.08				
Pumps pre-heatin	g venti	lation			W/m <sup>2</sup> 0							
Part 7: Mechan	ical ve	ntilation	<u>n systen</u>	n (heat	ing mod	<u>le)</u>						
Supply temperatu			ıre	Duration								
Weekdays		°C				h/day	h/day n/a					
Saturdays		°C				h/day						
Sundays		°C				h/day						
Ventilation rate, o	occupai	ncy peric	od, m <sup>3</sup> /hr	n²								
Ventilation rate, r	non-occ	upancy,	m³/hm²									
Heat recovery eff	ïciency	, %										
Emission efficiency, %												

Distribution efficiency	, %						
Automatic control, %							
Generation efficiency,	%						
Energy source (fuel, energy carrier)							
Fans, occupancy period, W/m <sup>2</sup>							
Fans, non-occupancy p	period, W/m <sup>2</sup>						
Part 8: Domestic hot	water syste	<u>ms</u>					
Quantity			l/m²year		220		
Temperature differenc		°C		35			
Distribution efficiency			%		100		
Automatic control %			%		94		
Generation efficiency		%		100			
Energy source (fuel, en		-		Electricity			
Pumps, DHW system		W/m <sup>2</sup>		0			
Part 9: Cooling mod	<u>e</u>						
	Set-poin temperatu	it ire	Duration				
Weekdays	°C		h/day		n/a		
Saturdays	°C		h/day				
Sundays	°C		h/day				
Unoccupied period	°C						
Holidays	°C						
Part 10: Cooling sys	tem	N					
Emission efficiency			%		n/a		
Distribution efficiency			%				
Automatic control			%				
Generation efficiency			%				
Fans/pumps room unit	s		W/m <sup>2</sup>				
Pumps cooling system			W/m <sup>2</sup>	W/m <sup>2</sup>			
Part 11: Mechanical	ventilation	system (co	ooling mode)				
	Supply temperatur	e		Duration			
Weekdays	°C		h/day		n/a		

Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupa	ncy period,	m³/hm²		
Ventilation rate, non-oc	cupancy, m	³/hm²		
Heat recovery efficienc	y, %			
Night - cooling, m <sup>3</sup> /hm	2			
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>				
Emission efficiency,%				
Distribution efficiency,	%			
Automatic control, %				
Generation efficiency,	%			
Fans, occupancy period	, W/m²			
Fans, non-occupancy pe	eriod, W/m <sup>2</sup>			
Fans, night cooling, W/	m <sup>2</sup>			
Fans, free-cooling, W/n	1 <sup>2</sup>			
Part 12: Appliances n	ot influen	cing the th	ermal balance	
	Av simultar	verage neous power		Duration
Weekdays	V	W/m <sup>2</sup>	h/day	0
Saturdays	/	W/m <sup>2</sup>	h/day	0

## III. Building category: Offices/Public administration

#### **Subcategory: Office building**

Sundays

- $\circ$  The reference building should have built-up area less than 5000 m<sup>2</sup>,
- Construction materials masonry
- Occupancy schedule 8 h/day 5 days/week,
- Technical systems: central heating based on district heating

 $W/m^2$ 

#### Table HU3: Office/public administration, Office buildings

Building category		OFFICES/PUBLIC ADMINISTRATION
Subcategory		Office Building
Conditioned area	$m^2$	2510,4
Conditioned volume	m <sup>3</sup>	6940,5
Climatic zone		City: Budapest

h/day

0

Part 1: Building (Zone) geometry						
Walls, north	m <sup>2</sup>	116,8				
Walls, east	m <sup>2</sup>	285,7				
Walls, south	m <sup>2</sup>	156,9				
Walls, west	m <sup>2</sup>	30	4,3			
Windows, north	m <sup>2</sup>	64	4,8			
Windows, east	m <sup>2</sup>	31	3,8			
Windows, south	m <sup>2</sup>	24	1,7			
Windows, west	m <sup>2</sup>	29	5,2			
Roof	m <sup>2</sup>	47	8,1			
Floor	$m^2$	50	0,7			
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment Requirement a 2,1 0,45				
ΔUtb	W/m <sup>2</sup> K	Add on to U-wall to account for the effect of thermal bridges				
b(ground)	-					
b(un-conditioned space)	-					
b(adjacent sunspace)	-					
b(adjacent building)	$m^2$					
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,31	Requirement at 2014 1,6			
fraction of the window frame area	%					
g(F)	-	0,7	/83			
Uroof	W/m <sup>2</sup> K	Prior to investment 1,1	Requirement at 2014 0,25			
Ufloor	W/m <sup>2</sup> K	Prior to investment 0,6	Requirement at 2014 0,5			
3	-	0,	75			
α	-	0,	,6			
Infiltration, occupancy period	h <sup>-1</sup>	0,	,8			
Infiltration, non occupancy	$h^{-1}$	0,8				
Thermal capacity	Wh/m <sup>2</sup> K	152,4				
Part 3: Internal gains and operation	al schedule					
Metabolic heat (occupants)	W/m <sup>2</sup>		7			
Latent metabolic heat	W/m <sup>2</sup>					

Weekdays					h/day	8							
Saturdays					h/day		0						
Sundays					h/day		0						
Lighting for illun	ninatio	on		,	W/m <sup>2</sup>		5,5						
Weekdays					h/day					8			
Saturdays					h/day					0			
Sundays					h/day					0			
Lighting, emergency/controls					W/m <sup>2</sup>					n/a			
Weekdays					h/day								
Saturdays					h/day								
Sundays					h/day								
Appliances					W/m <sup>2</sup>					9			
Weekdays					h/day					8			
Saturdays					h/day					0			
Sundays					h/day					0			
Latent heat				W/m <sup>2</sup>		n/a							
Weekdays				h/day									
Saturdays					h/day								
Sundays					h/day								
Part 4: Holidays	<u>s</u>												
	Jan	Feb	Mar	Apr	May	Jun	Ju	ıl	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	0	1	2	0	0	)	1	0	1	0	3
Part 5: Heating	mode	-											
		Set-p temper	ooint rature		Duration								
Weekdays		°C	20		h/da	ay		8					
Saturdays		°C	18		h/da	ay		24					
Sundays		°C	18		h/da	ay		24					
Unoccupied period		°C	18										
Holidays		°C	18										
Part 6: Heating	syster	<u>n</u>											
Emission efficient	icy				%			100					
Distribution efficiency	%	98											
--------------------------------------	------------------	------------------											
Automatic control	%	99											
Generation efficiency	%	100											
Energy source (fuel, energy carrier)	-	District heating											
Fans/pumps room units	W/m <sup>2</sup>	0											
Pumps heating system	W/m <sup>2</sup>	0,07											
Pumps pre-heating ventilation	W/m <sup>2</sup>	0											

Part 7: Mechanical ventilation system (heating mode)

	Suj tempe	pply erature		I	Duration
Weekdays	°C		h/day		n/a
Saturdays	°C		h/day		
Sundays	°C		h/day		
Ventilation rate, occupar	ncy period, n	n³/hm²			
Ventilation rate, non-occ	cupancy, m <sup>3</sup> /	hm²			
Heat recovery efficiency	, %				
Emission efficiency, %					
Distribution efficiency,	%				
Automatic control, %					
Generation efficiency, %	)				
Energy source (fuel, energy	rgy carrier)				
Fans, occupancy period,	W/m <sup>2</sup>				
Fans, non-occupancy per	riod, W/m <sup>2</sup>				
Part 8: Domestic hot w	vater systen	<u>15</u>			
Quantity			l/m²year		220
Temperature difference			°C		35
Distribution efficiency			%		88
Automatic control %			%		96
Generation efficiency %			%		88
Energy source (fuel, energy	rgy carrier)		-		District heating
Pumps, DHW system			W/m <sup>2</sup>		0.05
Part 9: Cooling mode					
	Set-poin temperatu	t ire		Du	ration

			1		1	1
Weekdays	°C	26		h/day		8
Saturdays	°C	30		h/day		24
Sundays	°C	30		h/day		24
Unoccupied period	°C	30				
Holidays	°C	30				
Part 10: Cooling sy	<u>stem</u>					
Emission efficiency				%		100
Distribution efficience	сy			%		95
Automatic control				%		90
Generation efficiency	/			%		300
Fans/pumps room un	its			W/m <sup>2</sup>		2,5
Pumps cooling system	n			W/m <sup>2</sup>		0,3
Part 11: Mechanico	al ventilati	on system	(coo	oling mode)		
	Supply temper	ature				Duration
Weekdays	°C			h/day		n/a
Saturdays	°C			h/day		
Sundays	°C			h/day		
Ventilation rate, occu	pancy perio	od, m <sup>3</sup> /hm <sup>2</sup>				
Ventilation rate, non-	occupancy,	m³/hm²				
Heat recovery efficie	ncy, %					
Night - cooling, m <sup>3</sup> /h	1m <sup>2</sup>					
Free – cooling, m <sup>3</sup> /hr	n²					
Emission efficiency,	%					
Distribution efficience	cy, %					
Automatic control, %	)					
Generation efficiency	/, %					
Fans, occupancy peri	od, W/m²					
Fans, non-occupancy	period, W/	m <sup>2</sup>				
Fans, night cooling, V	W/m <sup>2</sup>					
Fans, free-cooling, W	//m²					
Part 12: Appliances	s not influ	encing the	the	rmal balance		
	simul	Average taneous pov	wer			Duration
Weekdays		W/m <sup>2</sup>		h/day		0
	•					

Saturdays	W/m <sup>2</sup>	h/day	0
Sundays	W/m <sup>2</sup>	h/day	0

## **IV.** Building category: Educational buildings

#### Subcategory: Kindergartens

- $\circ$  The reference building should have built-up area less than 5000  $\,m^2,$
- Construction materials precast reinforced concrete unit
- Occupancy schedule: 8 h/day 5 days/week,
- Technical systems:
- $\circ$  central heating based on gas burning water heating boiler
- DHW based on electricity.

#### Table HU4: Educational buildings, Kindergartens

Building category		EDUCATION	AL BUILDINGS			
Subcategory		Kinder	rgartens			
Conditioned area	m <sup>2</sup>	57	72,7			
Conditioned volume	m <sup>3</sup>	1718				
Climatic zone		City: Budapest				
Part 1: Building (Zone) geometry						
Walls, north	m <sup>2</sup>	13	31,4			
Walls, east	m <sup>2</sup>	6	i8,8			
Walls, south	m <sup>2</sup>	(	0,6			
Walls, west	m <sup>2</sup>	1	8,9			
Windows, north	m <sup>2</sup>		94			
Windows, east	m <sup>2</sup>	1	1,4			
Windows, south	m <sup>2</sup>	9	93,9			
Windows, west	m <sup>2</sup>		0			
Roof	m <sup>2</sup>	5	70,7			
Floor	m <sup>2</sup>	5	72,7			
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment 0,44	Requirement at 2014 0,45			
ΔUtb	W/m <sup>2</sup> K	Add on to U-wall to a therma	account for the effect of l bridges			
b(ground)	-					
b(un-conditioned space)	-					
b(adjacent sunspace)	-					

b(adjacent building)	m <sup>2</sup>		
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,6	Requirement at 2014 1,6
fraction of the window frame area	%	Taken into account	t in Uwindows and g
g(F)	-	0,	783
Uroof	W/m <sup>2</sup> K	Prior to investment 1,43	Requirement at 2014 0,25
Ufloor	W/m <sup>2</sup> K	Prior to investment 1,07	Requirement at 2014 0,5
3	-	0	,75
α	-	(	),6
Infiltration, occupancy period	$h^{-1}$	(	),9
Infiltration, non occupancy	$h^{-1}$	(	),9
Thermal capacity	Wh/m <sup>2</sup> K	11	17,6
Part 3: Internal gains and operation	nal schedule		
Metabolic heat (occupants)	W/m <sup>2</sup>		9
Latent metabolic heat	W/m <sup>2</sup>		n/a
Weekdays	h/day		8
Saturdays	h/day		0
Sundays	h/day		0
Lighting for illumination	W/m <sup>2</sup>		3
Weekdays	h/day		8
Saturdays	h/day		0
Sundays	h/day		0
Lighting, emergency/controls	W/m <sup>2</sup>		n/a
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		
Appliances	W/m <sup>2</sup>		6
Weekdays	h/day		8
Saturdays	h/day		0
Sundays	h/day		0
Latent heat	W/m <sup>2</sup>		n/a
Weekdays	h/day		
Saturdays	h/day		
Sundays	h/day		

Part 4: Holida	<u>ays</u>											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	2	0	0	6	2	7	23	21	0	1	4	5
Part 5: Heating mode						-	-	-	-	-		
Set-point temperature					Duration							
Weekdays		°C	22		h/da	ay				10		
Saturdays		°C	19		h/da	ay				24		
Sundays		°C	19		h/da	ay				24		
Unoccupied period		°C	19									
Holidays		°C	18									
Part 6: Heatin	ng sys	<u>tem</u>										
Emission effici	iency				%	% 100						
Distribution ef	ficienc	:y			%	% 97						
Automatic con	trol				%		Ī			95		
Generation eff	iciency	/			%					99		
Energy source	(fuel,	energy ca	arrier)		-				Į	gas		
Fans/pumps ro	om un	its			W/n	n <sup>2</sup>				0		
Pumps heating	syster	n			W/n	$n^2$			0	,07		
Pumps pre-hea	ting ve	entilation			W/n	n²				0		
Part 7: Mecho	anical	ventilat	tion sys	tem (he	eating m	node)						
			Sup temper	ply rature				Du	ration			
Weekdays			°C			h/o	day			n/	a	
Saturdays			°C			h/o	lay					
Sundays			°C			h/o	day					
Ventilation rate	e, occi	ipancy pe	eriod, m	³/hm²								
Ventilation rate	e, non-	occupan	cy, m³/h	m <sup>2</sup>								
Heat recovery	efficie	ncy, %										
Emission effici	iency,	%										
Distribution ef	ficienc	cy, %										

Automatic control, %	, 0						
Generation efficiency	y, %						
Energy source (fuel,	energy carrier)						
Fans, occupancy peri	iod, W/m <sup>2</sup>						
Fans, non-occupancy	/ period, W/m <sup>2</sup>						
Part 8: Domestic h	ot water system	<u>ms</u>					
Quantity			l/m²year		170		
Temperature differen	nce		°C		35		
Distribution efficient		%		90			
Automatic control %			%		100		
Generation efficiency	у %		%		100		
Energy source (fuel,		-		Electricity			
Pumps, DHW system		W/m <sup>2</sup>		0			
Part 9: Cooling mo	<u>ode</u>						
	Set-poin temperati	it ire		Duration			
Weekdays	°C		h/day		n/a		
Saturdays	°C		h/day				
Sundays	°C		h/day				
Unoccupied period	°C						
Holidays	°C						
Part 10: Cooling sy	<u>vstem</u>						
Emission efficiency			%				
Distribution efficient	су		%				
Automatic control			%				
Generation efficiency	у		%				
Fans/pumps room un	nits		W/m <sup>2</sup>				
Pumps cooling system	m		W/m <sup>2</sup>				
Part 11: Mechanic	al ventilation	<u>system (co</u>	oling mode)				
	Supply temperatur	e			Duration		
Weekdays	°C		h/day		n/a		
Saturdays	°C		h/day				
Sundays	°C		h/day				

Ventilation rate, occupanc	y period, m <sup>3</sup> /hm <sup>2</sup>		
Ventilation rate, non-occu	pancy, m <sup>3</sup> /hm <sup>2</sup>		
Heat recovery efficiency,	%		
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>			
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>			
Emission efficiency,%			
Distribution efficiency, %			
Automatic control, %			
Generation efficiency, %			
Fans, occupancy period, W	V/m <sup>2</sup>		
Fans, non-occupancy perio	od, W/m <sup>2</sup>		
Fans, night cooling, W/m <sup>2</sup>			
Fans, free-cooling, W/m <sup>2</sup>			
Part 12: Appliances not	influencing the the	rmal balance	
	Average simultaneous power		Duration
Weekdays	W/m <sup>2</sup>	h/day	0
Saturdays	W/m <sup>2</sup>	h/day	0

## V. Building category: Educational buildings

#### **Subcategory: Schools**

Sundays

 $\circ$   $\,$  The reference building should have built-up area between  $\,$  5000 and 10000  $\,$  m^2,  $\,$ 

h/day

• Construction materials – precast reinforced concrete unit

 $W/m^2$ 

- Occupancy schedule: 8 h/day 5 days/week,
- Technical systems: central heating based on district heating

#### **Table HU5: Educational buildings, Schools**

0

Building category		EDUCATIONAL BUILDINGS
Subcategory		School
Conditioned area	m <sup>2</sup>	5212,6
Conditioned volume	m <sup>3</sup>	17466,7
Climatic zone		City: Budapest
Part 1: Building (Zone) geometry		
Walls, north	m <sup>2</sup>	480,8

XX 7 11	2	50	2		
Walls, east	2	53	2		
Walls, south	m²	516	6,7		
Walls, west	m²	51	5		
Windows, north	m <sup>2</sup>	35	4		
Windows, east	m <sup>2</sup>	570	),9		
Windows, south	m <sup>2</sup>	291	,3		
Windows, west	m <sup>2</sup>	595,5			
Roof	m <sup>2</sup>	3101,2			
Floor	m <sup>2</sup>	2424,4			
Part 2: Building (Zone) properties					
Uwalls	W/m <sup>2</sup> K	Prior to investment 2,14	Requirement at 2014 0,45		
ΔUtb	W/m <sup>2</sup> K	Add on to U-wall to account for the effect of thermal bridges			
b(ground)	-				
b(un-conditioned space)	-				
b(adjacent sunspace)	-				
b(adjacent building)	m <sup>2</sup>				
Uwindows	W/m <sup>2</sup> K	Prior to investment 3,2	Requirement at 2014 1,6		
fraction of the window frame area	%	Taken into account	in Uwindows and g		
g(F)	-	0,7	/83		
Uroof	W/m <sup>2</sup> K	Prior to investment 0,7	Requirement at 2014 0,25		
Ufloor	W/m <sup>2</sup> K	Prior to investment 0,6	Requirement at 2014 0,5		
3	-	0,	75		
α	-	0	,6		
Infiltration, occupancy period	$h^{-1}$	2	,5		
Infiltration, non occupancy	h <sup>-1</sup>	0	,3		
Thermal capacity	Wh/m <sup>2</sup> K	11	7,6		
Part 3: Internal gains and operation	al schedule				
Metabolic heat (occupants)	W/m <sup>2</sup>		)		
Latent metabolic heat	W/m <sup>2</sup>	n	/a		
Weekdays	h/day	8	3		
Saturdays	h/day	(	)		
Sundays	h/day	(	)		

Lighting for illu	minati	on			W/m <sup>2</sup>				6			
Weekdays					h/day				8			
Saturdays					h/day				0			
Sundays					h/day				0			
Lighting, emerg	ency/c	ontrols			W/m <sup>2</sup>				0			
Weekdays					h/day							
Saturdays					h/day							
Sundays					h/day							
Appliances					W/m <sup>2</sup>				6			
Weekdays					h/day				8			
Saturdays					h/day				0			
Sundays					h/day				0			
Latent heat					W/m <sup>2</sup>				n/a			
Weekdays					h/day							
Saturdays					h/day							
Sundays					h/day							
Part 4: Holiday	<u>vs</u>											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	<b>Jan</b> 2	Feb           0	<b>Mar</b> 0	<b>Apr</b> 6	<b>May</b> 2	<b>Jun</b> 7	<b>Jul</b> 23	<b>Aug</b> 21	<b>Sep</b> 0	<b>Oct</b>	<b>Nov</b>	<b>Dec</b> 5
No. of holidays (excluding weekends) Part 5: Heating	Jan 2 z mode	Feb           0	<b>Mar</b> 0	<b>Apr</b> 6	<b>May</b> 2	<b>Jun</b> 7	<b>Jul</b> 23	<b>Aug</b> 21	<b>Sep</b> 0	<b>Oct</b> 1	<b>Nov</b> 4	<b>Dec</b> 5
No. of holidays (excluding weekends) Part 5: Heating	Jan 2 g mode	Feb 0 Set-I tempe	Mar 0 point rature	<b>Apr</b> 6	<b>Мау</b> 2	<b>Jun</b> 7	<b>Jul</b> 23	Aug 21 Durat	<b>Sep</b> 0 ion	Oct 1	<b>Nov</b> 4	<b>Dec</b> 5
No. of holidays (excluding weekends) Part 5: Heating Weekdays	Jan 2 g mode	Feb 0 2 Set-p tempe	Mar 0 point rature 20	<b>Apr</b> 6	May 2 h/d	Jun 7 ay	<b>Jul</b> 23	Aug 21 Durat	<b>Sep</b> 0 <b>ion</b>	<b>Oct</b> 1 8	<b>Nov</b> 4	<b>Dec</b> 5
No. of holidays (excluding weekends) Part 5: Heating Weekdays Saturdays	Jan 2 g mode	Feb 0 2 5 5 6 C °C	Mar 0 Doint rature 20 18	<b>Apr</b> 6	May 2 h/d	Jun 7 ay	<b>Jul</b> 23	Aug 21 Durat	<b>Sep</b> 0 <b>ion</b>	Oct           1           8           24	<b>Nov</b> 4	<b>Dec</b> 5
No. of holidays (excluding weekends) Part 5: Heating Weekdays Saturdays Sundays	Jan 2 g mode	Feb 0 2 2 Set-p tempe °C °C	Mar           0           oint           rature           20           18           18	<b>Apr</b> 6	May 2 h/d h/d	Jun 7 ay ay	<b>Jul</b> 23	Aug 21 Durat	<b>Sep</b> 0 <b>ion</b>	Oct           1           8           24           24	<b>Nov</b> 4	<b>Dec</b> 5
No. of holidays (excluding weekends) Part 5: Heating Weekdays Saturdays Saturdays Sundays Unoccupied period	Jan 2 g mode	Feb       0       2       Set-p       tempe       °C	Mar           0           ooint           rature           20           18           18           18	<b>Apr</b> 6	May 2 h/d h/d	Jun 7 ay ay ay	Jul 23	Aug 21 Durat	<b>Sep</b> 0 <b>ion</b>	Oct           1           8           24           24	<b>Nov</b> 4	5
No. of holidays (excluding weekends) Part 5: Heating Weekdays Saturdays Saturdays Sundays Unoccupied period Holidays	Jan 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	Feb           0           2           Set-p           tempe           °C           °C	Mar           0           ooint           rature           20           18           18           18           18           18           18           18	Apr           6	May 2 h/d h/d	Jun 7 ay ay	Jul 23	Aug 21 Durat	Sep           0	Oct           1           8           24           24	Nov           4	<b>Dec</b> 5
No. of holidays (excluding weekends) Part 5: Heating Weekdays Saturdays Sundays Sundays Unoccupied period Holidays Part 6: Heating	Jan 2 g mode	Feb           0           2           Set-p           tempe           °C	Mar           0           point           rature           20           18           18           18           18	Apr         6         1         0         1         <	May 2 h/d h/d	Jun 7 ay ay ay	Jul 23	Aug 21 Durat	Sep           0	Oct           1           8           24           24	<b>Nov</b> 4	<b>Dec</b> 5
No. of holidays (excluding weekends) Part 5: Heating Weekdays Saturdays Sundays Sundays Unoccupied period Holidays Part 6: Heating Emission efficie	Jan 2 g mode g mode g syste ncy	Feb           0           2           Set-p           *C           °C	Mar         0         ooint         rature         20         18         18         18         18	Apr 6	May 2 h/d h/d h/d	Jun 7 ay ay	Jul 23	Aug 21 Durat	<b>Sep</b> 0 ion 1	Oct 1 8 24 24 24 00	Nov           4	5
No. of holidays (excluding weekends) Part 5: Heating Weekdays Saturdays Saturdays Sundays Unoccupied period Holidays Part 6: Heating Emission efficie Distribution efficie	Jan 2 g mode g syste ncy ciency	Feb           0           2           Set-p           *C           °C	Mar         0         ooint         rature         20         18         18         18         18         18         18	Apr 6	May 2 h/d h/d h/d %	Jun 7 ay ay ay	Jul 23	Aug 21 Durat	Sep           0           ion           1	Oct           1           8           24           24           00           99	Nov           4	<b>Dec</b> 5

Generation efficiency

%

99

Energy source (fuel,	energy carrier)		-	District heating
Fans/pumps room u	nits		W/m <sup>2</sup>	0
Pumps heating syste	m		W/m <sup>2</sup>	0,07
Pumps pre-heating v	ventilation		W/m <sup>2</sup>	0
Part 7: Mechanica	l ventilation sy	estem (hea	ting mode)	
	Suj tempe	pply erature		Duration
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occ	upancy period, r	n³/hm²		
Ventilation rate, non	n-occupancy, m <sup>3</sup> /	hm²		
Heat recovery efficie	ency, %			
Emission efficiency,	, %			
Distribution efficien	су, %			
Automatic control, %				
Generation efficienc	ey, %			
Energy source (fuel,	energy carrier)			
Fans, occupancy per	riod, W/m <sup>2</sup>			
Fans, non-occupancy	y period, W/m <sup>2</sup>			
Part 8: Domestic h	ot water system	ns		
Quantity			l/m²year	170
Temperature differen	nce		°C	35
Distribution efficien	су		%	87
Automatic control %	, )		%	97
Generation efficienc	ey %		%	85
Energy source (fuel,	energy carrier)		-	District heating
Pumps, DHW system		W/m <sup>2</sup>	0.03	
Part 9: Cooling me	<u>ode</u>			
	Set-point temperatu	re		Duration
Weekdays	°C		h/day	n/a
Saturdays	°C		h/day	
Sundays	°C		h/day	

Unoccupied period	°C					
Holidays	°C					
Part 10: Cooling sy	<u>stem</u>					
Emission efficiency				%		
Distribution efficience	ÿ			%		
Automatic control				%		
Generation efficiency	1			%		
Fans/pumps room un	its			W/m <sup>2</sup>		
Pumps cooling system	n			W/m <sup>2</sup>		
Part 11: Mechanico	al ventilat	ion systen	n (co	ooling mode)		
	Supply temper	ature				Duration
Weekdays	°C			h/day		n/a
Saturdays	°C			h/day		
Sundays	°C			h/day		
Ventilation rate, occu	ipancy peri	od, m³/hm	2			
Ventilation rate, non-	occupancy	, m³/hm²				
Heat recovery efficie	ncy, %					
Night - cooling, m <sup>3</sup> /h	nm <sup>2</sup>					
Free – cooling, m <sup>3</sup> /hr	n²					
Emission efficiency,	%					
Distribution efficienc	zy, %					
Automatic control, %						
Generation efficiency	<i>,</i> %					
Fans, occupancy peri	od, W/m²					
Fans, non-occupancy	period, W	/m <sup>2</sup>				
Fans, night cooling, V	W/m²					
Fans, free-cooling, W/m <sup>2</sup>						
Part 12: Appliances	<u>s not influ</u>	encing th	e the	ermal balance		
	sim	Average	powe	r		Duration
Weekdays		W/m <sup>2</sup>		h/d	ay	0
Saturdays		W/m <sup>2</sup>		h/d	ay	0
Sundays		$W/m^2$		h/d	ay	0

## VI. Building category: Residential

### Subcategory: Student housing

- The reference building should have built-up area between 5000 and 10000 m2,
- Construction materials precast reinforced concrete unit,
- $\circ$  Occupancy schedule 24 h/day 7 days/week,
- Technical systems: central heating based on gas burning water heating boiler

#### Table HU6: Residential, Student housing

Building category		RES	SIDENTIAL				
Subcategory		STUDE	STUDENT HOUSING				
Conditioned area	m <sup>2</sup>	8311 (Based on external dimensions)					
Conditioned volume	m <sup>3</sup>	22509	22509 (net volume)				
Climatic zone		Cit	y: Budapest				
Part 1: Building (Zone) geometry							
Walls, north-east	m <sup>2</sup>		574,8				
Walls, south-east	m <sup>2</sup>		441,7				
Walls, south-west	m <sup>2</sup>		574,9				
Walls, north-west	m <sup>2</sup>		531,3				
Windows, north-east	m <sup>2</sup>		580,7				
Windows, south-east	m <sup>2</sup>		71,5				
Windows, south-west	m <sup>2</sup>		559,3				
Windows, north-west	m <sup>2</sup>		43,5				
Roof	m <sup>2</sup>		1321,8				
Floor	m <sup>2</sup>		1321,8				
Part 2: Building (Zone) propertie	<u>'S</u>						
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,12	Requirement at 2014 0,45				
ΔUtb	W/m <sup>2</sup> K	Add on to U-wall to acc bridges	count for the effect of thermal				
b(ground)	-						
b(un-conditioned space)	-						
b(adjacent sunspace)	-						
b(adjacent building)	$m^2$						
Uwindows	Uwindows W/m <sup>2</sup> K		Requirement at 2014 1,6				
fraction of the window frame area	%	Taken into ac	count in Uwindows				

g(F)				-					0,783			
Uroof				W/m <sup>2</sup>	К	Prior to investment 0,53 Requirement at 2 0,25					ent at 20 25	014
Ufloor				W/m <sup>2</sup>	К	Prior to investment Re 1,52			quirem 0	ent at 20 ,5	014	
3				-					0,75			
α				-					0,6			
Infiltration, occ	upancy	period		$h^{-1}$					1			
Infiltration, non	occupa	incy		$h^{-1}$					1			
Thermal capaci	ty			Wh/m	<sup>2</sup> K				88,7			
Part 3: Interne	al gain:	s and o	peration	nal sch	<u>edule</u>							
Metabolic heat	(occup	ants)		v	V/m²				5,5			
Latent metabol	ic heat			V	V/m²				n/a			
Weekdays				h	/day				24			
Saturdays				h	/day				24			
Sundays				h	/day	24						
Lighting for ill	uminati	on		W/m <sup>2</sup>		5						
Weekdays					/day		6					
Saturdays				h	/day		6					
Sundays				h	/day				6			
Lighting, emerg	gency/c	ontrols		V	V/m <sup>2</sup>				n/a			
Weekdays	S			h	/day							
Saturdays	aturdays											
Sundays				h	/day							
Appliances				V	V/m²				8			
Weekdays	/eekdays			h	/day				24			
Saturdays				h	/day				24			
Sundays				h	/day	24						
Latent heat					V/m²				n/a			
Weekdays				h	/day							
Saturdays				h	/day							
Sundays				h	/day	у						
Part 4: Holida	<u>vs</u>											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays	0	0	0	0	0	0	0	0	0	0	0	0

(excluding weekends)													
Part 5: Heating r	<u> </u>		<u>.</u>	<u></u>		0	<u>ų</u>	<u>+</u>					
	1	Set-p	ooint ratur	e					Durati	ion			
Weekdays		°C	2	)	]	n/da	ay				24		
Saturdays		°C	20	)	]	n/da	ay				24		
Sundays		°C	2	C	1	n/da	ау				24		
Unoccupied period		°C	2	)									
Holidays		°C	2	)									
Part 6: Heating s	systen	<u>n</u>											
Emission efficience	сy				(	%				1	00		
Distribution efficie	ency				(	%				9	5,6		
Automatic control					(	%				8	8,2		
Generation efficiency				%				92,6					
Energy source (fuel, energy carrier)			-				gas						
Fans/pumps room units				W/m <sup>2</sup>				0					
Pumps heating sys	stem				W	W/m <sup>2</sup> 0,04							
Pumps pre-heating	g venti	ilation			W	W/m <sup>2</sup> 0							
<u>Part 7: Mechanie</u>	cal ve	ntilati	on sys	stem (	<u>heating</u>	m	ode)						
		t	Sup empe	ply rature	•	Duration							
Weekdays		°(	С				h/da	ıy			n/a	ı	
Saturdays		°(	С				h/da	ny					
Sundays		°(	С				h/da	ay					
Ventilation rate, or	ccupa	ncy per	riod, m	<sup>3</sup> /hm <sup>2</sup>									
Ventilation rate, no	on-oco	cupanc	y, m³/l	nm²									
Heat recovery efficiency, %													
Emission efficiency, %													
Distribution efficiency, %													
Automatic control, %													
Generation efficiency, %													
Energy source (fue	el, ene	ergy car	rier)										
Fans, occupancy period, W/m <sup>2</sup>													

Fans, non-occupancy	period, W	/m <sup>2</sup>						
Part 8: Domestic h	ot water sy	v <u>stems</u>						
Quantity				l/m²year			740	
Temperature differen	nce			°C			35	
Distribution efficience	су			%			88	
Automatic control %				%			93	
Generation efficiency	y %			%			90,9	
Energy source (fuel,	energy carr	ier)		-			gas	
Pumps, DHW system	1			W/m <sup>2</sup>			0,05	
Part 9: Cooling mo	<u>ode</u>							
Set-point temperature						Du	iration	
Weekdays	°C			h/day			n/a	
Saturdays	°C		h/day					
Sundays	°C		h/day					
Unoccupied period	°C							
Holidays	°C							
Part 10: Cooling sy	<u>stem</u>							
Emission efficiency				%			n/a	
Distribution efficient	су			%				
Automatic control				%				
Generation efficiency	у			%				
Fans/pumps room un	its			W/m <sup>2</sup>				
Pumps cooling system	m			W/m <sup>2</sup>				
Part 11: Mechanico	al ventilati	ion system	(cool	ing mode)				
	Supply temper	ature					Duration	
Weekdays	°C		h/day				n/a	
Saturdays	°C			h/day				
Sundays	°C			h/day				
Ventilation rate, occu	upancy peri	od, m <sup>3</sup> /hm <sup>2</sup>				<u> </u>		
Ventilation rate, non-	-occupancy	, m <sup>3</sup> /hm <sup>2</sup>	$\top$					
Heat recovery efficie	ency, %		$\top$					

Night - cooling, m <sup>3</sup> /hm <sup>2</sup>				
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W/m <sup>2</sup>				
Fans, non-occupancy period, W/m <sup>2</sup>				
Fans, night cooling, W/m <sup>2</sup>				
Fans, free-cooling, W/m <sup>2</sup>				
Part 12: Appliances not influencing the thermal balance				

	Average simultaneous power		Duration
Weekdays	W/m <sup>2</sup>	h/day	0
Saturdays	W/m <sup>2</sup>	h/day	0
Sundays	W/m <sup>2</sup>	h/day	0

# ITALY

## **Definition of data**

A second list of indicators has now to be considered:

Characteristic	Symbol
Climatic zone	-
Period of construction	-
Total gross floor area [m <sup>2</sup> ]	А
Total net floor area [m <sup>2</sup> ]	A <sub>n</sub>
Footprint [m <sup>2</sup> ]	-
Envelope surface [m <sup>2</sup> ]	Se
Window surface [m <sup>2</sup> ]	$\mathbf{S}_{\mathbf{w}}$
Gross volume [m <sup>3</sup> ]	V
Net volume [m <sup>3</sup> ]	Vn
Number of floors	-
Medium height of floor [m]	h
Compactness ratio [m <sup>-1</sup> ]	S <sub>e</sub> /V
Window/Envelope surface ratio	S <sub>w</sub> /S <sub>e</sub>
Window/Floor surface ratio	$S_w / A_n$

#### Table IT 1 – Building general and dimensional data list

Because of its geographical characteristics, Italy is subdivided into six climatic zones according to the heating degree days. For different climatic zones also the building services and the referred energy consumption are different. The present work is focused on the climatic zone E, characterized by 2101-3000 heating degree days, because of its highest amount of public buildings, as shown in Figure IT 1 for two of the three building categories defined. Data refers to climatic zones E and F together, but Figure IT 2 highlights the climatic zone F corresponds to a slight portion of the country, often situated in mountains, in which the public building density is poor and thus not representative of the whole nation.



Figure IT 1 – Public building distribution for Italian climatic zone



Figure IT 2 - Subdivision of Italy in climatic zones according to heating degree days

The period of construction is necessary in order to correctly define the building systems and the technological systems of the building stock. Concerning the period of construction for climatic zone E, the collected data referred to offices and residential buildings are shown in Figure IT 3, while for schools the subdivision in time steps is articulated in Figure IT 4.



Figure IT 3 – Residential and office building stock period of construction in climatic zone E



Figure IT 4 – Schools building stock period of construction in climatic zone E

The Italian study will be focused on two periods of construction for each category; the chosen period will be the most representative in terms of consistency of the building stock for each category. Thus:

- $\circ$  years up to 1919 will be considered for both residential buildings and offices;
- offices after 1991 reach the 16,4%, while the three periods in between 1962 and 1991 obtain a value around 11%;
- $\circ$  the two periods in between 1962 and 1981 show the 18% of residential buildings;
- $\circ~$  the 40% of the building stock for schools is built in the period 1964-1983, while another 23% in between 1944 and 1963.

According to what mentioned before, the reference building are thus chosen as shown in Table IT 2.

Building category	CLIMATIC ZONE	PERIOD OF CONSTRUCTION				
Residential	E	Up to $1010$	1962 to 1971			
(Social housing)	Ľ	Op to 1919	1972 to 1981			
Offices						
(Public admin.)	E	Up to 1919	After 1991			
(Local authorities)						
Education	E	1944 to 1963	1964 to 1983			

Table IT 2 - Italian public building stock definition through indicators

Building category	CLIMATIC ZONE	PERIOD OF CONSTRUCTION			
(Schools)					

For those periods and for each category, the medium and the mode have been defined as to consider the most representative building for each cathegory, according to the available data. Table IT 3. summarizes results for offices.

Table IT 3 - Building general and	d dimensional	data collection	for offices
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		Up	to 1919	1920	to 1945	1946 t	o 1961	1962 to	1971	1972 t	o 1981	1982 t	o 1991	After	1991
Characteristic	Symbol	MEDIUM	MODE	MEDIUM	MODE	MEDIUM	MODE	MEDIUM	MODE	MEDIUM	MODE	MEDIUM	MODE	MEDIUM	MODE
Total grossfloor area [m <sup>2</sup> ]	A	958	225	715	225	512	225	579	225	560	225	1004	225	1004	225
Total net floor area [m <sup>2</sup> ]	A <sub>n</sub>														
Footprint [m <sup>2</sup> ]	-	295	113	250	113	177	113	166	113	173	113	322	113	314	113
Envelope surface [m <sup>2</sup> ]	S.	683	343	548	343	433	523	502	523	506	523	798	523	808	523
Window surface [m <sup>2</sup> ]	Sw	90	30	82	30	72	30	70	30	95	60	123	30	113	60
Gross volume [m <sup>3</sup> ]	V	3353	788	2501	788	1792	788	2025	788	1960	788	3513	788	3515	788
Net volume [m <sup>3</sup> ]	Vn														
Number of floors	-	3,2	2,0	2,9	2,0	2,9	2,0	3,5	2,0	3,2	2,0	3,1	2,0	3,2	2,0
Medium height of floor [m]	h	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5	3,5
Compactness ratio [m <sup>-1</sup> ]	S/V	0,20	0,44	0,22	0,44	0,24	0,66	0,25	0,66	0,26	0,66	0,23	0,66	0,23	0,66
Window/Envelope surface ratio	S₀/S₀	0,13	0,09	0,15	0,09	0,17	0,06	0,14	0,06	0,19	0,11	0,15	0,06	0,14	0,11
Window/Roor surface ratio	S <sub>w</sub> /A <sub>n</sub>	0,09	0,13	0,11	0,13	0,14	0,13	0,12	0,13	0,17	0,27	0,12	0,13	0,11	0,27

Finally, the Public Administration of the Turin metropolitan area has been asked to check up to two real public buildings for each building category. The choise should respect either the project data collection achieved, and the Public Administration real interest in performing the building refurbishment. The following public buildings have thus been chosen:

- o SOCIAL HOUSING
  - a) Via Ivrea/Carema, Turin (Ref. SocialHousing)
- OFFICES
  - a) M.I.U.R. Administrative Service Center, Turin
- $\circ$  SCHOOLS
  - a) High school Cattaneo, Turin (Ref. School)
  - b) High School Einstein, Turin (Ref. School)

#### I. Building category: Educational buildings

#### **Subcategory: Schools**

#### **Table IT 4: Educational buildings, Schools**

Building category			Educational building		
Subcategory			School		
Conditioned area		m <sup>2</sup>	m <sup>2</sup> Net: 8764		
Conditioned volume		m <sup>3</sup>	41781 (337	72)	
Climatic zone E			Ref.number: School01	City: Turin	
Part 1: Building (gym) geomet	<u>ry</u>				
Walls, north west, M9, pillar	m <sup>2</sup>		38,88		
Walls, north west, M7, wall 3	m <sup>2</sup>		619,35		
Walls, south east, M9, pillar m <sup>2</sup>		38,88			

	1	
Walls, south east, M7, wall 3	m <sup>2</sup>	545,61
Walls, south west, M9, pillar	m <sup>2</sup>	19,44
Walls, south west, M7, wall 3	m <sup>2</sup>	343,73
Walls, north east, M9, pillar	m <sup>2</sup>	19,44
Walls, north east, M7, wall 3	m <sup>2</sup>	345,60
Windows, north west, F2	m <sup>2</sup>	25,41
Windows, south west, F2	m <sup>2</sup>	13,31
Windows, south east, F2	m <sup>2</sup>	49,61
Windows, south east, F4	m <sup>2</sup>	38,50
Windows, south east, F10	m <sup>2</sup>	11,04
Windows, north east, F2	m <sup>2</sup>	14,52
Roof S2	m <sup>2</sup>	855,48
Windows (roof), F14	m <sup>2</sup>	157,32
Floor on the ground P3	m <sup>2</sup>	1012,80
Part 1: Building (school) geom	<u>netry</u>	
Walls, north west, M10, pillar	m <sup>2</sup>	66,24
Walls, north west, M5, wall 1	m <sup>2</sup>	835,29
Walls, north west, M8, wall 4	m <sup>2</sup>	81,00
Walls, south east, M10, pillar	m <sup>2</sup>	66,24
Walls, south east, M5, wall 1	m <sup>2</sup>	944,66
Walls, south west, M10, pillar	m <sup>2</sup>	22,08
Walls, south west, M5, wall 1	m <sup>2</sup>	249,38
Walls, north east, M10, pillar	m <sup>2</sup>	22,08
Walls, north east, M5, wall 1	m <sup>2</sup>	322,42
Walls, on C.T. M11	m <sup>2</sup>	99
Windows, north west, F2	m <sup>2</sup>	159,72
Windows, north west, F8	m <sup>2</sup>	68,40
Windows, north west, F7	m <sup>2</sup>	36,45
Windows, north west, F12	m <sup>2</sup>	28,86
Windows, north west, F16	m <sup>2</sup>	62,00
Windows, south west, F9	m <sup>2</sup>	13,68
Windows, south west, F7	m <sup>2</sup>	4,05
Windows, south east, F2	m <sup>2</sup>	246,84
Windows, south east, F11	m <sup>2</sup>	26,86
Windows, south east, F15	m <sup>2</sup>	24,48
Windows, south east, F16	m <sup>2</sup>	93,00
Windows, north east, F7	m <sup>2</sup>	2,43

Roof on unconditioned space S1	$m^2$		1841,59			
Windows (roof), F6	m <sup>2</sup>		(25,41)			
Floor on the ground P1	m <sup>2</sup>		1763,00	1763,00		
Floor on C.T. P2	m <sup>2</sup>		103,75			
Floor on outside P4	m <sup>2</sup>		34,50			
Part 2: Building (Gym&School	) proper	ties				
Uwalls		W/m <sup>2</sup> K	Prior to investment	Requirement at 2014		
Uwalls M5		W/m <sup>2</sup> K	0,88	0,34		
Uwalls M8		W/m <sup>2</sup> K	1,17	0,34		
Uwalls M10		W/m <sup>2</sup> K	2,52	0,34		
Uwalls M11		W/m <sup>2</sup> K	1,90	0,34		
Upillar P1		W/m <sup>2</sup> K	0,24	0,34		
Upillar P2		W/m <sup>2</sup> K	0,84	0,34		
Upillar P4		$W/m^2K$	0,92	0,34		
ΔUtb		W/m <sup>2</sup> K				
b(ground)		-	0,53			
b(un-conditioned space)		-	0,70			
b(adjacent sunspace)		-				
b(adjacent building)		-				
Uwindows		W/m <sup>2</sup> K	Prior to investment	Requirement at 2014		
Uwindows F2		W/m <sup>2</sup> K	3,87	2,2		
Uwindows F6		W/m <sup>2</sup> K	5,79	2,2		
Uwindows F7		W/m <sup>2</sup> K	4,04	2,2		
Uwindows F8		W/m <sup>2</sup> K	3,48	2,2		
Uwindows F9		W/m <sup>2</sup> K	3,87	2,2		
Uwindows F11		W/m <sup>2</sup> K	6,23	2,2		
Uwindows F12		W/m <sup>2</sup> K	3,42	2,2		
Uwindows F15		W/m <sup>2</sup> K	3,38	2,2		
Uwindows F16		W/m <sup>2</sup> K	3,57	2,2		
fraction of the window frame area		%	17	7%		
g(F)		0,75	Total solar energy transpected external shading for norm	nittance for window incl. nal incidence		
Uroof		W/m <sup>2</sup> K	Prior to investment	Requirement at 2014		
Uroof S1		W/m <sup>2</sup> K	0,93	0,30		

Uroof S3	W/m <sup>2</sup> K	0,97	0,30				
Ufloor	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014				
Ufloor P1	W/m <sup>2</sup> K	0,24	0,33				
Ufloor P2	W/m <sup>2</sup> K	0,84	0,33				
Ufloor P4	W/m <sup>2</sup> K	0,92	0,33				
3	-	0,84 Glass 0,90 Opaque components	5				
α	-	0,3-0,6					
Infiltration, occupancy period	$h^{-1}$	1,	12				
Infiltration, non occupancy	$h^{-1}$	1,	12				
Thermal capacity	Wh/m <sup>2</sup> K	43 referred to the total	building envelope area				
Part 3: Internal gains and operational schedule							
Sensible heat gains	W/m <sup>2</sup>		4				
Latent heat gains	W/m <sup>2</sup>	0,011 0,00	school 8 gym				
Weekdays	h/day	8					
Saturdays	h/day	8					
Sundays	h/day	8					
Metabolic heat (occupants)	W/m <sup>2</sup>	0					
Latent metabolic heat	W/m <sup>2</sup>	0 for cooling calculation					
Weekdays	h/day						
Saturdays	h/day						
Sundays	h/day						
Lighting for illumination	W/m <sup>2</sup>						
Weekdays	h/day						
Saturdays	h/day						
Sundays	h/day						
Lighting, emergency/controls	W/m <sup>2</sup>		0				
Weekdays	h/day						
Saturdays	h/day						
Sundays	h/day						
Appliances	W/m <sup>2</sup>		0				
Weekdays	h/day						
Saturdays	h/day						
Sundays	h/day						

Latent heat			W/m <sup>2</sup>			(	0 For co	oling ca	lculatio	ns		
Weekdays			h	/day								
Saturdays			h	h/day								
Sundays				h	/day							
<u>Part 4: Holida</u>	<u>ys</u>			<u>.</u>								
	Jan	Feb	Mar	Apr	Apr May		Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0
Part 5: Heating	g mode	2										
	Set-point temperature							Durati	on			
Weekdays		°C	20		h/da	ay				24		
Saturdays		°C 20			h/day			24				
Sundays		°C 20			h/day			24				
Unoccupied period	cupied °C 20											
Holidays		°C	20									
Part 6: Heating	g syste	<u>m</u>										
Emission efficie	ncy				%				96	,2		
Distribution effi	ciency				%			97				
Automatic contr	ol				%			82,5				
Generation effic	iency				%			78,6				
Energy source (f	fuel, en	ergy car	rier)		-			natural gas				
Fans/pumps room	m units				W/m <sup>2</sup>			_				
Pumps heating s	ystem				W/m <sup>2</sup>			1,72				
Pumps pre-heati	ng vent	ilation			W/m <sup>2</sup>				-			
<u>Part 7: Mechai</u>	nical v	<u>entilatio</u>	on syste	m (hea	ting mo	ode)						
		t	Supp empera	ly ture	Duration							
Weekdays		°(	C			h/da	h/day h/day with full ventilation rate (occupancy period)				n rate	
Saturdays		°(	C		h/day							
Sundays		°C			h/day							

Ventilation rate, occu	upancy period, m <sup>3</sup> /hm <sup>2</sup>	2	
Ventilation rate, non-	-occupancy, m <sup>3</sup> /hm <sup>2</sup>		
Heat recovery efficie	ency, %		
Emission efficiency,	%		
Distribution efficient	су, %		
Automatic control, %	, )		
Generation efficiency	y, %		
Energy source (fuel,	energy carrier)		
Fans, occupancy peri	iod, W/m <sup>2</sup>		
Fans, non-occupancy	v period, W/m <sup>2</sup>		
Part 8: Domestic h	ot water systems		
Quantity		l/m²year	32,85
Temperature differer	nce	°C	27,2
Distribution efficient	су	%	
Automatic control %		%	
Generation efficiency	y %	%	
Energy source (fuel,	energy carrier)	-	
Pumps, DHW system	1	W/m <sup>2</sup>	
Part 9: Cooling mo	<u>de</u>		
	Set-point temperature		Duration
Weekdays	°C	h/day	h/day with set-point temperature
Saturdays	°C	h/day	
Sundays	°C	h/day	
Unoccupied period	°C		
Holidays	°C		
Part 10: Cooling sy	o <u>stem</u>		
Emission efficiency		%	
Distribution efficient	су	%	
Automatic control		%	
Generation efficiency	у	%	
Fans/pumps room un	its	W/m <sup>2</sup>	
Pumps cooling system	m	W/m <sup>2</sup>	

Part 11: Mechanical v	entilation s	ystem (coo	<u>ling mode)</u>			
	Supply temperature	e	Duration			
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)		
Saturdays	°C		h/day			
Sundays	°C		h/day			
Ventilation rate, occupat	ncy period, n	n³/hm²				
Ventilation rate, non-occ	cupancy, m <sup>3</sup> /	hm²				
Heat recovery efficiency	<sup>,</sup> %					
Night – cooling, m <sup>3</sup> /hm <sup>2</sup>						
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>						
Emission efficiency,%						
Distribution efficiency,	%					
Automatic control, %						
Generation efficiency, %	, )					
Fans, occupancy period,	W/m <sup>2</sup>					
Fans, non-occupancy pe	riod, W/m <sup>2</sup>					
Fans, night cooling, W/r	n²					
Fans, free-cooling, W/m	2					
Part 12: Appliances n	ot influenci	ng the ther	rmal balance			
Average simultaneous powe		verage leous power	r Duration			
Weekdays	V	V/m <sup>2</sup>	h/day			
Saturdays	V	V/m <sup>2</sup>	h/day			
Sundays	V	V/m <sup>2</sup>	h/day			

## II. Building category: Educational buildings

## Subcategory: Schools

### Table IT4: Educational buildings, Schools

Building category		Educational building
Subcategory		School
Conditioned area	m <sup>2</sup>	8798 (school) 2149 (gym&theatre)
Conditioned volume	m <sup>3</sup>	27339 (school)

		7957 (gym&theatre)					
Climatic zone E		Ref.number: School02	City: Turin				
Part 1: Building geometry (level -1)							
Walls, north east, M14	m <sup>2</sup>	27,36					
Walls, north east, M13	m <sup>2</sup>	134,30					
Walls, north west, M14	m <sup>2</sup>	23,04					
Walls, north west, M13	m <sup>2</sup>	139,09					
Walls, south west, M14	m <sup>2</sup>	37,44					
Walls, south west, M13	m <sup>2</sup>	143,78					
Door on unconditioned space, M4	m <sup>2</sup>	4,04					
Door on unconditioned space, M5	m <sup>2</sup>	2,13					
Walls on unconditioned space, M19	m <sup>2</sup>	146,89					
Walls, south east, M14	m <sup>2</sup>	44,64					
Walls, south east, M13	m <sup>2</sup>	197,38					
Windows, north east, F20	m <sup>2</sup>	15,54					
Windows, north east, F8	m <sup>2</sup>	38,02					
Windows, north east, F30	m <sup>2</sup>	3,08					
Windows, north west, F10	m <sup>2</sup>	7,92					
Windows, north west, F20	m <sup>2</sup>	49,73					
Windows, south west, F8	m <sup>2</sup>	59,75					
Windows, south west, F27	m <sup>2</sup>	8,06					
Windows, south west, F29	m <sup>2</sup>	1,68					
Windows, south west, F20	m <sup>2</sup>	3,11					
Windows, south east, F10	m <sup>2</sup>	14,51					
Windows, south east, F8	m <sup>2</sup>	54,32					
Windows, south east, F20	m <sup>2</sup>	34,19					
Floor on ground, P1	m <sup>2</sup>	1700					
Part 1: Building geometry (ground	<u>floor)</u>						
Walls, north east, M14	m <sup>2</sup>	28,63					
Walls, north east, M13	m <sup>2</sup>	126,61					
Walls, north west, M14	m <sup>2</sup>	41,63					
Walls, north west, M13	m <sup>2</sup>	184,45					
Walls, south west, M14	m <sup>2</sup>	43,07					
Walls, south west, M13	m <sup>2</sup>	112,66					
Walls, south east, M14	m <sup>2</sup>	51,84					
Walls, south east, M13	m <sup>2</sup>	162,45					

Windows, north east, F1	m <sup>2</sup>	33,4					
Windows, north east, F2	m <sup>2</sup>	18,34					
Windows, north east, F8	m <sup>2</sup>	51,60					
Windows, north east, F9	m <sup>2</sup>	4,89					
Windows, north west, F8	m <sup>2</sup>	76,05					
Windows, north west, F18	m <sup>2</sup>	2,91					
Windows, north west, F3	m <sup>2</sup>	3,45					
Windows, north west, F19	m <sup>2</sup>	2,54					
Windows, north west, F10	m <sup>2</sup>	10,55					
Windows, north west, F9	m <sup>2</sup>	2,44					
Windows, south west, F8	m <sup>2</sup>	78,76					
Windows, south west, F9	m <sup>2</sup>	2,44					
Windows, south west, F1	m <sup>2</sup>	16,70					
Windows, south west, F2	m <sup>2</sup>	9,17					
Windows, south east, F3	m <sup>2</sup>	6,90					
Windows, south east, F10	m <sup>2</sup>	15,83					
Windows, south east, F8	m <sup>2</sup>	97,78					
Floor on unconditioned space, P2	m <sup>2</sup>	204					
Part 1: Building geometry (level 1)							
Walls, north east, M14	m <sup>2</sup>	28,68					
Walls, north east, M13	m <sup>2</sup>	126,87					
Walls, north west, M14	m <sup>2</sup>	41,63					
Walls, north west, M13	m <sup>2</sup>	182,77					
Walls, south west, M14	m <sup>2</sup>	43,20					
Walls, south west, M13	m <sup>2</sup>	106,97					
Walls, south east, M14	m <sup>2</sup>	51,84					
Walls, south east, M13	m <sup>2</sup>	164,07					
Windows, north east, F15	m <sup>2</sup>	16,70					
Windows, north east, F16	m <sup>2</sup>	8,91					
Windows, north east, F13	m <sup>2</sup>	5,93					
Windows, north east, F14	m <sup>2</sup>	3,24					
Windows, north east, F11	m <sup>2</sup>	10,80					
Windows, north east, F12	m <sup>2</sup>	5,90					
Windows, north east, F8	m <sup>2</sup>	51,60					
Windows, north east, F9	m <sup>2</sup>	4,89					
Windows, north west, F8	m <sup>2</sup>	76,05					
	2	01.11					

Windows, north west, F9	m <sup>2</sup>	2,44
Windows, south west, F8	m <sup>2</sup>	81,48
Windows, south west, F10	m <sup>2</sup>	5,28
Windows, south west, F11	m <sup>2</sup>	10,80
Windows, south west, F12	m <sup>2</sup>	5,90
Windows, south west, F13	m <sup>2</sup>	5,93
Windows, south west, F14	m <sup>2</sup>	3,24
Windows, south east, F10	m <sup>2</sup>	21,11
Windows, south east, F8	m <sup>2</sup>	97,78
Part 1: Building geometry (level 2)		
Walls, north east, M14	m <sup>2</sup>	28,68
Walls, north east, M13	m <sup>2</sup>	126,87
Walls, north west, M14	m <sup>2</sup>	41,63
Walls, north west, M13	m <sup>2</sup>	182,77
Walls, south west, M14	m <sup>2</sup>	43,20
Walls, south west, M13	m <sup>2</sup>	106,97
Walls, south east, M14	m <sup>2</sup>	51,84
Walls, south east, M13	m <sup>2</sup>	164,07
Windows, north east, F15	m <sup>2</sup>	16,70
Windows, north east, F16	m <sup>2</sup>	8,91
Windows, north east, F13	m <sup>2</sup>	5,93
Windows, north east, F14	m <sup>2</sup>	3,24
Windows, north east, F11	m <sup>2</sup>	10,80
Windows, north east, F12	m <sup>2</sup>	5,90
Windows, north east, F8	m <sup>2</sup>	51,60
Windows, north east, F9	m <sup>2</sup>	4,89
Windows, north west, F8	m <sup>2</sup>	76,05
Windows, north west, F10	m <sup>2</sup>	21,11
Windows, north west, F9	m <sup>2</sup>	2,44
Windows, south west, F8	m <sup>2</sup>	81,48
Windows, south west, F10	m <sup>2</sup>	5,28
Windows, south west, F11	m <sup>2</sup>	10,80
Windows, south west, F12	m <sup>2</sup>	5,90
Windows, south west, F13	m <sup>2</sup>	5,93
Windows, south west, F14	m <sup>2</sup>	3,24
Windows, south east, F10	m <sup>2</sup>	21,11
Windows, south east, F8	m <sup>2</sup>	97,78

Roof on unconditioned space, S2	m <sup>2</sup>	38,81						
Roof on outside, S1	m <sup>2</sup>	1828,79						
Part 1: Building geometry (level 3)								
Walls, north east, M13	m <sup>2</sup>	18,32						
Walls, north west, M13	m <sup>2</sup>	6,32						
Walls, south east, M13	m <sup>2</sup>	4,09						
Wall on unconditioned space, M19		26,59						
Door, south east, M2	m <sup>2</sup>	1,71						
Door on unconditioned space, M1	m <sup>2</sup>	2,10						
Door on unconditioned space, M3	m <sup>2</sup>	2,63						
Windows, north west, F10	m <sup>2</sup>	5,28						
Windows, north east, F17	m <sup>2</sup>	9,52						
Roof on outside, S1	m <sup>2</sup>	36,40						
Part 1: Building geometry (gym&theat	re)							
Walls, north east, M15	m <sup>2</sup>	63,14						
Walls, north east, M17	m <sup>2</sup>	112,75						
Walls, north west, M18	m <sup>2</sup>	32,40						
Walls, north west, M15	m <sup>2</sup>	110,17						
Walls, north west, M17	m <sup>2</sup>	230,91						
Walls, south west, M15	m <sup>2</sup>	32,91						
Walls, south west, M17	m <sup>2</sup>	92,86						
Walls, south east, M16	m <sup>2</sup>	30,38						
Walls, south east, M15	m <sup>2</sup>	77,73						
Walls, south east, M17	m <sup>2</sup>	210,10						
Door, south east, M9	m <sup>2</sup>	3,30						
Door, south east, M7	m <sup>2</sup>	3,82						
Door, north east, M6	$m^2$	3,08						
Door, north east, M12	m <sup>2</sup>	2,75						
Door, north west, M7	m <sup>2</sup>	3,82						
Door, north west, M12	m <sup>2</sup>	2,75						
Windows, north west, F23	m <sup>2</sup>	24,31						
Windows, north west, F25	m <sup>2</sup>	41,60						
Windows, north west, F24	$m^2$	1,20						
Windows, north west, F6	m <sup>2</sup>	10,08						
Windows, north west, F7	m <sup>2</sup>	5,04						
Windows, north west, F26	$m^2$	4,28						

Windows, north west, F22	m <sup>2</sup>	90,64					
Windows, south west, F23	m <sup>2</sup>	24,32					
Windows, south west, F24	m <sup>2</sup>	2,41					
Windows, south east, F31	$m^2$	1,62					
Windows, south east, F25	m <sup>2</sup>	39					
Windows, south east, F24	m <sup>2</sup>	2,41					
Windows, south east, F23	m <sup>2</sup>	43,78					
Windows, south east, F22	m <sup>2</sup>	90,64					
Floor on ground	$m^2$	662,37					
Floor on unconditioned space, P2	$m^2$	53,94					
Roof on outside, S1	$m^2$	716,3	1				
Part 2: Building (Gym&School) pro	perties						
Uwalls	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014				
Udoor M1	W/m <sup>2</sup> K	4,07	2,2				
Udoor M2	W/m <sup>2</sup> K	6,03	2,2				
Udoor M3	W/m <sup>2</sup> K	4,07	2,2				
Udoor M4	W/m <sup>2</sup> K	1,84	2,2				
Udoor M5	W/m <sup>2</sup> K	4,07	2,2				
Udoor M6	W/m <sup>2</sup> K	6,03	2,2				
Udoor M7	W/m <sup>2</sup> K	6,03	2,2				
Udoor M9	W/m <sup>2</sup> K	6,03	2,2				
Udoor M12	$W/m^2K$	6,03	2,2				
Uwalls M13	W/m <sup>2</sup> K	0,91	0,34				
Uwalls M14	$W/m^2K$	1,40	0,34				
Uwalls M15	W/m <sup>2</sup> K	0,83	0,34				
Uwalls M16	$W/m^2K$	1,18	0,34				
Uwalls M17	$W/m^2K$	1,20	0,34				
Uwalls M18	$W/m^2K$	1,40	0,34				
Uwalls M19	W/m <sup>2</sup> K	1,88 0,80					
ΔUtb	$W/m^2K$	-					
b(ground)	-	0,45					
b(un-conditioned space)	-	0,27					
b(adjacent sunspace)	-						
b(adjacent building)	-						
Uwindows	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014				

Uwindows F1	W/m <sup>2</sup> K	5,60	2,2		
Uwindows F2	W/m <sup>2</sup> K	5,59	2,2		
Uwindows F3	W/m <sup>2</sup> K	5,71	2,2		
Uwindows F6	W/m <sup>2</sup> K	5,67	2,2		
Uwindows F7	W/m <sup>2</sup> K	5,67	2,2		
Uwindows F8	W/m <sup>2</sup> K	3,55	2,2		
Uwindows F9	W/m <sup>2</sup> K	3,58	2,2		
Uwindows F10	W/m <sup>2</sup> K	5,98	2,2		
Uwindows F11	W/m <sup>2</sup> K	3,41	2,2		
Uwindows F12	W/m <sup>2</sup> K	5,79	2,2		
Uwindows F13	W/m <sup>2</sup> K	3,40	2,2		
Uwindows F14	W/m <sup>2</sup> K	5,81	2,2		
Uwindows F15	W/m <sup>2</sup> K	3,32	2,2		
Uwindows F16	W/m <sup>2</sup> K	3,31	2,2		
Uwindows F17	W/m <sup>2</sup> K	5,95	2,2		
Uwindows F18	W/m <sup>2</sup> K	6,01	2,2		
Uwindows F19	W/m <sup>2</sup> K	6,17	2,2		
Uwindows F20	W/m <sup>2</sup> K	3,52	2,2		
Uwindows F22	W/m <sup>2</sup> K	5,73	2,2		
Uwindows F23	W/m <sup>2</sup> K	6,01	2,2		
Uwindows F24	W/m <sup>2</sup> K	6,20	2,2		
Uwindows F25	W/m <sup>2</sup> K	5,78	2,2		
Uwindows F26	W/m <sup>2</sup> K	5,96	2,2		
Uwindows F27	W/m <sup>2</sup> K	3,62	2,2		
Uwindows F29	W/m <sup>2</sup> K	4,43	2,2		
Uwindows F30	W/m <sup>2</sup> K	3,63	2,2		
Uwindows F31	W/m <sup>2</sup> K	3,65	2,2		
Uwindows F6	W/m <sup>2</sup> K		2,2		
Uwindows F7	W/m <sup>2</sup> K		2,2		
Uwindows F8	W/m <sup>2</sup> K		2,2		
fraction of the window frame area	%	17	/%		
g(F)	0,85	Total solar energy transmittance for window incl external shading for normal incidence			
Uroof	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014		
Uroof S1	W/m <sup>2</sup> K	1,00	0,30		
Uroof S2	W/m <sup>2</sup> K	0,93	0,80		
Ufloor	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014		

Ufloor P1	W/m <sup>2</sup> K	0,29	0,33			
Ufloor P2	W/m <sup>2</sup> K	0,83	0,80			
e	_	0,84 0	Glass			
	_	0,90 Opaque	components			
α	-	0,6				
<b>T</b> C <sup>1</sup>	1 -1	0,5 (gym)				
Infiltration, occupancy period	h	2,5 (theatre) 1.7 (school)				
		0.5 (s	ym)			
Infiltration, non occupancy	$\mathbf{h}^{-1}$	2,5 (th	eatre)			
		1,7 (sc	chool)			
Thermal capacity	Wh/m <sup>2</sup> K	46 referred to the total	building envelope area			
Part 3: Internal gains and operation	nal schedule					
Sensible heat gains	W/m <sup>2</sup>		1			
	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	0.011	school			
Latent heat gains	W/m <sup>2</sup>	0,011 senior				
		0,008 gym				
Weekdays	h/day	8				
Saturdays	h/day	8				
Sundays	h/day	8				
Metabolic heat (occupants)	W/m <sup>2</sup>	0				
Latent metabolic heat	W/m <sup>2</sup>	0 For cooling	calculations			
Weekdays	h/day					
Saturdays	h/day					
Sundays	h/day					
Lighting for illumination	W/m <sup>2</sup>	(	)			
Weekdays	h/day					
Saturdays	h/day					
Sundays	h/day					
Lighting, emergency/controls	W/m <sup>2</sup>	(	)			
Weekdays	h/day					
Saturdays	h/day					
Sundays	h/day					
Appliances	W/m <sup>2</sup>	(	)			
Weekdays	h/day					
Saturdays	h/day					

Sundays					h/day								
Latent heat					W/m <sup>2</sup>		0 For cooling calculations						
Weekdays				h/day									
Saturdays					h/day								
Sundays					h/day								
Part 4: Holidays													
	Jan	Feb	Mai	: A	pr May	Jun	J	ul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	(	0 0	0	(	0	0	0	0	0	0
Part 5: Heatin	ig mod	<u>le</u>											
Set-point temperature				e					Durati	on			
Weekdays		°C	2	0	h/o	lay		24					
Saturdays		°C	2	0	h/o	lay		24					
Sundays		°C	2	0	h/o	lay		24					
Unoccupied period		°C	20	0									
Holidays		°C	2	0									
Part 6: Heatin	ig syst	<u>em</u>											
Emission effici	ency				%			96,7					
Distribution efficiency					%			97,2					
Automatic cont	rol				%			82,9					
Generation effi	ciency				%			77,4					
Energy source	(fuel, e	nergy ca	rrier)		- natural gas								
Fans/pumps roo	om uni	ts			W/m <sup>2</sup>								
Pumps heating	system	l			W/r	n²				1,	00		
Pumps pre-heat	ing ve	ntilation			W/r	n <sup>2</sup>				-	-		
Part 7: Mecha	<u>inical</u>	<u>ventilat</u>	ion sy	stem	(heating n	<u>node)</u>							
		1	Suj tempe	oply cratur	e				Dur	ation			
Weekdays		(	°C			h/	day		h	/day wit (oc	th full ve cupancy	entilatio period)	n rate
Saturdays		(	°C			h/	h/day						

Sundays	°C		h/da	у				
Ventilation rate, occupancy period, m <sup>3</sup> /hm <sup>2</sup>								
Ventilation rate, nor	n-occupancy, m <sup>3</sup> /	/hm²						
Heat recovery effici								
Emission efficiency	, %							
Distribution efficien	ксу, %							
Automatic control,	%							
Generation efficience	cy, %							
Energy source (fuel,	, energy carrier)							
Fans, occupancy per	riod, W/m <sup>2</sup>							
Fans, non-occupanc	y period, W/m <sup>2</sup>							
Part 8: Domestic I	not water system	<u>ns</u>						
Quantity			l/m²year		32,85			
Temperature differe	nce		°C		27,2			
Distribution efficien	icy		%					
Automatic control %	/ 0		%					
Generation efficience	су %		%		95,1%			
Energy source (fuel,	, energy carrier)		-		natural gas			
Pumps, DHW system	m		W/m <sup>2</sup>					
Part 9: Cooling m	<u>ode</u>							
	Set-poin temperatu	t re	Duration					
Weekdays	°C		h/day	h/d	ay with set-point temperature			
Saturdays	°C		h/day					
Sundays	°C		h/day					
Unoccupied period	°C							
Holidays	°C							
Part 10: Cooling s	Part 10: Cooling system							
Emission efficiency			%					
Distribution efficien	lcy		%					
Automatic control			%					
Generation efficience	су		%					
Fans/pumps room units			W/m <sup>2</sup>					

Pumps cooling system			W/m <sup>2</sup>				
Part 11: Mechanical	ventilation system	n (coo	ling mode)				
Supply temperature			Duration				
Weekdays	°C		h/day		h/day with full ventilation rate (occupancy period)		
Saturdays	°C		h/day				
Sundays	°C		h/day				
Ventilation rate, occupa	ncy period, m <sup>3</sup> /hm	l <sup>2</sup>					
Ventilation rate, non-oc	cupancy, m <sup>3</sup> /hm <sup>2</sup>						
Heat recovery efficiency	y, %						
Night – cooling, m <sup>3</sup> /hm <sup>2</sup>	2						
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>							
Emission efficiency,%							
Distribution efficiency,	%						
Automatic control, %							
Generation efficiency, 9	6						
Fans, occupancy period	, W/m²						
Fans, non-occupancy pe	eriod, W/m <sup>2</sup>						
Fans, night cooling, W/2	m²						
Fans, free-cooling, W/n	1 <sup>2</sup>						
Part 12: Appliances n	ot influencing th	ne ther	rmal balance				
	Average simultaneous p	ower			Duration		
Weekdays	W/m <sup>2</sup>		h/day	/			
Saturdays	W/m <sup>2</sup>		h/day	/			
Sundays	W/m <sup>2</sup>		h/day	/			

## III. Building category: Residential buildings

## Subcategory: Social housing

### Table IT5: Residential buildings, Social housing

Building category		Residential		
Subcategory		Social housing		
Conditioned area	m <sup>2</sup>	16280		

Conditioned volume	m <sup>3</sup>	50485						
Climatic zone E		Ref.number: SocialHousing01 City Turin						
Part 1: Building geometry								
Walls, north, M1	m <sup>2</sup>			378,2				
Walls, south, M1	m <sup>2</sup>			378,2				
Walls, east, M1	m <sup>2</sup>			3037,6				
Walls, west, M1	m <sup>2</sup>			2989,6				
Windows, north, F1	m <sup>2</sup>			19,2				
Windows, north, F2	m <sup>2</sup>			6,0				
Windows, north, F4	m <sup>2</sup>			33,6				
Windows, south, F1	m <sup>2</sup>			19,2				
Windows, south, F2	m <sup>2</sup>			6,0				
Windows, south, F4	m <sup>2</sup>			33,6				
Windows, east, F1	m <sup>2</sup>			268,8				
Windows, east, F2	m <sup>2</sup>			72				
Windows, east, F3	m <sup>2</sup>		201,6					
Windows, west, F1	m <sup>2</sup>		556,8					
Windows, west, F3	m <sup>2</sup>							
Roof S1	m <sup>2</sup>	1990						
Floor on unconditioned space P1	m <sup>2</sup>	1628						
Part 2: Building properties								
Uwalls	W/m <sup>2</sup> K		Prior to inves	stment	Requirement	at 2014		
Uwalls M1	W/m <sup>2</sup> K		1,43		0,34			
ΔUtb	W/m <sup>2</sup> K							
b(ground)	-							
b(un-conditioned space)	-	C	,80					
b(adjacent sunspace)	-							
b(adjacent building)	-							
Uwindows	W/m <sup>2</sup> K		Prior to investment		Requirement	at 2014		
Uwindows F1	W/m <sup>2</sup> K		5,70		2,2			
Uwindows F2	W/m <sup>2</sup> K		5,70		2,2			
Uwindows F3	W/m <sup>2</sup> K		5,70		2,2			
Uwindows F4	W/m <sup>2</sup> K		5,70		2,2			
fraction of the window frame area	%	20%						
--------------------------------------	---------------------	--	------------------------	--	--			
g(F)	0,75	Total solar energy transmittance for window in external shading for normal incidence						
Uroof	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014					
Uroof S1	W/m <sup>2</sup> K	1,35	0,30					
Ufloor	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014					
Ufloor P1	W/m <sup>2</sup> K	1,59	0,33					
3	-	0,84 0,90 Opaque	Glass e components					
α	-	0,3	-0,6					
Infiltration, occupancy period	$\mathbf{h}^{-1}$	C	,3					
Infiltration, non occupancy	$h^{-1}$	0	,3					
Thermal capacity	Wh/m <sup>2</sup> K	43 referred to the total	building envelope area					
Part 3: Internal gains and operation	al schedule							
Sensible heat gains	W/m <sup>2</sup>	5,8						
Latent heat gains	W/m <sup>2</sup>	2,95						
Weekdays	h/day	24						
Saturdays	h/day	24						
Sundays	h/day	24						
Metabolic heat (occupants)	W/m <sup>2</sup>		0					
Latent metabolic heat	W/m <sup>2</sup>	0 for coolin	g calculation					
Weekdays	h/day							
Saturdays	h/day							
Sundays	h/day							
Lighting for illumination	W/m <sup>2</sup>							
Weekdays	h/day							
Saturdays	h/day							
Sundays	h/day							
Lighting, emergency/controls	W/m <sup>2</sup>		0					
Weekdays	h/day							
Saturdays	h/day							
Sundays	h/day							
Appliances	W/m <sup>2</sup>		0					
Weekdays	h/day							
Saturdays	h/day							

Sundays				h/day									
Latent heat				W/m <sup>2</sup>			0 For cooling calculations						
Weekdays				h/day									
Saturdays					h/	day							
Sundays					h/	day							
Part 4: Holida	<u>ys</u>			•									
	Jan	Feb	Ma	r A	pr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0		0	0	0	0	0	0	0	0	0
Part 5: Heatin;	g mod	2											
	Set-point temperature								Duratio	on			
Weekdays		°C	2	0		h/da	y				24		
Saturdays		°C	2	0	h/day 24								
Sundays		°C	2	0	h/day 24			24					
Unoccupied period		°C	20	0									
Holidays		°C	2	0									
Part 6: Heating	g syste	<u>m</u>											
Emission efficie	ency				% 95								
Distribution effi	ciency				%			9	94				
Automatic contr	ol				% 90			6					
Generation effic	iency					%				9	5		
Energy source (	fuel, en	ergy car	rier)			-				natura	al gas		
Fans/pumps roo	m units	5				W/m <sup>2</sup>		-					
Pumps heating s	ystem					W/m <sup>2</sup>		1,2					
Pumps pre-heati	ng ven	tilation				W/m <sup>2</sup>				_			
Part 7: Mechai	nical v	entilati	on sys	stem (	(heat	ting mo	de)						
		te	Sup empe	ply ratur	'e				Dura	ation			
Weekdays		°(	C				h/da	у	h/	day witl (occ	n full ve upancy	ntilatior period)	n rate
Saturdays		°(	C			h/day							

Sundays	°C		h	/day			
Ventilation rate, occ	on rate, occupancy period, m <sup>3</sup> /hm <sup>2</sup>			-	I		
Ventilation rate, non	-occupancy,	m <sup>3</sup> /hm <sup>2</sup>					
Heat recovery efficie	ency, %						
Emission efficiency,	%						
Distribution efficient	су, %						
Automatic control, %	6						
Generation efficienc	y, %						
Energy source (fuel,	energy carri	er)					
Fans, occupancy per	iod, W/m <sup>2</sup>						
Fans, non-occupancy	y period, W/r	n²					
Part 8: Domestic h	ot water sys	<u>stems</u>					
Quantity			l/m²yea	ır	361		
Temperature differen		°C		27,2			
Distribution efficient		%					
Automatic control %	)		%				
Generation efficienc	у %		%		95		
Energy source (fuel,	energy carri	er)	-		natural gas		
Pumps, DHW system	n		W/m <sup>2</sup>		0,3		
Part 9: Cooling mo	<u>ode</u>						
	Set-po	oint		Duration			
XX7 1 1	temper	ature	1./1	1./	1 11 1 1 1 1		
Weekdays	°C		h/day	h/o	lay with set-point temperature		
Saturdays	°C		n/day				
Sundays	°C		n/day				
Holidaya	°C						
Part 10: Cooling s	vstem						
	stent	<u> </u>					
Emission efficiency			%				
Distribution efficient	су		%				
Automatic control	¥7		% 0/				
Fans/numps room ur	y nits		70 W/m <sup>2</sup>				
Fans/pumps room units			vv / 111				
Pumps cooling syste	m		$W/m^2$				

Part 11: Mechanical	ventilation system (co	oling mode)	
	Supply temperature		Duration
Weekdays	°C	h/day	h/day with full ventilation rate (occupancy period)
Saturdays	°C	h/day	
Sundays	°C	h/day	
Ventilation rate, occupa	ancy period, m <sup>3</sup> /hm <sup>2</sup>		
Ventilation rate, non-oc	cupancy, m <sup>3</sup> /hm <sup>2</sup>		
Heat recovery efficiency	y, %		
Night – cooling, m <sup>3</sup> /hm <sup>2</sup>	2		
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>			
Emission efficiency,%			
Distribution efficiency,	%		
Automatic control, %			
Generation efficiency, 9	%		
Fans, occupancy period	, W/m <sup>2</sup>		
Fans, non-occupancy pe	eriod, W/m <sup>2</sup>		
Fans, night cooling, W/2	m <sup>2</sup>		
Fans, free-cooling, W/m	n <sup>2</sup>		
Part 12: Appliances n	ot influencing the the	ermal balance	
	Average simultaneous power		Duration
Weekdays	W/m <sup>2</sup>	h/day	
Saturdays	W/m <sup>2</sup>	h/day	
Sundays	W/m <sup>2</sup>	h/day	

# IV. Building category: Office/Administrative buildings

## Subcategory: Offices

## **Table IT6: Office buildings, Offices**

Building category		Office
Subcategory		Office
Conditioned area	$m^2$	2772
Conditioned volume	m <sup>3</sup>	9240

Climatic zone E		Ref.number: Office101	l City: Turin			
Part 1: Building geometry						
Walls, north, M1	m <sup>2</sup>		481,8			
Walls, south, M1	m <sup>2</sup>		481,8			
Walls, east, M1	m <sup>2</sup>		260,2			
Walls, west, M1	m <sup>2</sup>		260,2			
Windows, north, F1	m <sup>2</sup>		178,2			
Windows, south, F1	m <sup>2</sup>		178,2			
Windows, east, F1	m <sup>2</sup>		19,8			
Windows, west, F1	m <sup>2</sup>		19,8			
Roof S1	m <sup>2</sup>		462			
Floor on unconditioned space P1	m <sup>2</sup>		462			
Part 2: Building properties						
Uwalls	W/n	n <sup>2</sup> K	Prior to investment	Requirement at 2014		
Uwalls M1	W/m <sup>2</sup> K		0,76	0,34		
ΔUtb	W/n	n <sup>2</sup> K		u		
b(ground)	-					
b(un-conditioned space)	-		0,80			
b(adjacent sunspace)	-					
b(adjacent building)	-					
Uwindows	W/n	n <sup>2</sup> K	Prior to investment	Requirement at 2014		
Uwindows F1	W/n	n <sup>2</sup> K	3,20	2,2		
fraction of the window frame area	%	ó	20	)%		
g(F)	0,7	75	Total solar energy transmerses external shading for norm	nittance for window incl. nal incidence		
Uroof	W/n	n <sup>2</sup> K	Prior to investment	Requirement at 2014		
Uroof S1	W/r	n <sup>2</sup> K	0,83	0,30		
Ufloor	W/n	n <sup>2</sup> K	Prior to investment	Requirement at 2014		
Ufloor P1	W/n	n <sup>2</sup> K	0,52	0,33		
3	-		0,84 Glass 0,90 Opaque components	3		
α	-		0,6			
Infiltration, occupancy period	h-1		1,06			

Infiltration, non	occupa	ncy		h	l-1		1,06					
Thermal capacit	tity			Wh/	/m <sup>2</sup> K	43 referred to the total building envelope are						
Part 3: Internal gains and operational schedule												
Sensible heat g	le heat gains			V	V/m <sup>2</sup>	6						
Latent heat gai	Latent heat gains			V	V/m <sup>2</sup>				0,004			
Weekdays			h	/day				8				
Saturdays			h	/day				8				
Sundays				h	/day				8			
Metabolic heat	(оссира	ints)		V	V/m²				0			
Latent metaboli	ic heat			V	V/m²			0 for co	oling ca	lculatio	n	
Weekdays				h	/day							
Saturdays			h	/day								
Sundays	Sundays			h	/day							
Lighting for illu	Lighting for illumination			V	V/m²							
Weekdays			h	/day								
Saturdays			h	/day								
Sundays				h	/day	ay						
Lighting, emerg	gency/co	ontrols		V	W/m <sup>2</sup> 0							
Weekdays				h	h/day							
Saturdays				h	/day							
Sundays				h	/day							
Appliances				V	V/m²		0					
Weekdays				h	h/day							
Saturdays				h	h/day							
Sundays				h	/day		1					
Latent heat				V	V/m <sup>2</sup>	0 For cooling calculations						
Weekdays				h	/day							
Saturdays				h	/day							
Sundays	h	/day										
Part 4: Holida	<u>ys</u>											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	0	0	0	0	0	0	0	0	0	0	0	0

Part 5: Heating m	<u>ode</u>							
	Set- tempe	point cratu	re		Duration			
Weekdays	°C	2	20	h/day			24	
Saturdays	°C	2	20	h/day			24	
Sundays	°C	2	20	h/day			24	
Unoccupied period	°C	2	20					
Holidays	°C	2	20					
Part 6: Heating sy	ystem_							
Emission efficiency	1			%			97	
Distribution efficient	ncy			%			96	
Automatic control				%			97	
Generation efficiency			%			93		
Energy source (fuel, energy carrier)		-			natural gas			
Fans/pumps room units		W/m <sup>2</sup>	W/m <sup>2</sup>		-			
Pumps heating system			W/m <sup>2</sup>	<i>J</i> /m <sup>2</sup> 0,5		0,5		
Pumps pre-heating	ventilation			W/m <sup>2</sup>			-	
Part 7: Mechanic	al ventilat	ion sy	ystem (	(heating mode)				
	1	Suj cempe	pply eratur	e	Duration			
Weekdays	c	С		h/d	ay		h/day with full ventilation rate (occupancy period)	
Saturdays	C	C		h/d	ay			
Sundays	C	С		h/d	ay			
Ventilation rate, oc	cupancy pe	riod, 1	m³/hm²					
Ventilation rate, no	n-occupan	cy, m <sup>3</sup>	/hm²					
Heat recovery effic	iency, %							
Emission efficiency	v, %							
Distribution efficiency, %								
Automatic control,	%							
Generation efficien	су, %							
Energy source (fuel	l, energy ca	rrier)						
Fans, occupancy pe	eriod, W/m <sup>2</sup>	2						
Fans, non-occupancy period, W/m <sup>2</sup>								

Part 8: Domestic ho	t water syst	<u>ems</u>			
Quantity			l/m²year		73
Temperature difference			°C		27,2
Distribution efficiency	1		%		
Automatic control %			%		
Generation efficiency		%		93	
Energy source (fuel, e	nergy carrie	;)	-		
Pumps, DHW system			W/m <sup>2</sup>		0,1
Part 9: Cooling mod	<u>le</u>				
Set-point temperature				]	Duration
Weekdays	°C		h/day		h/day with set-point temperature
Saturdays	°C		h/day		
Sundays	°C		h/day		
Unoccupied period	°C				
Holidays	°C				
Part 10: Cooling sys	<u>tem</u>				
Emission efficiency			%		
Distribution efficiency	1		%		
Automatic control			%		
Generation efficiency			%		
Fans/pumps room uni	ts		W/m <sup>2</sup>		
Pumps cooling system	1		W/m <sup>2</sup>		
<u>Part 11: Mechanica</u>	l ventilation	<u>n system (</u>	<u>(cooling mode)</u>		
	Supply temperatur	re			Duration
Weekdays	°C		h/day		h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day		
Sundays	°C		h/day		
Ventilation rate, occup	pancy period	, m³/hm²			
Ventilation rate, non-o	occupancy, n	n <sup>3</sup> /hm <sup>2</sup>			
Heat recovery efficien	icy, %				
Night – cooling, m <sup>3</sup> /hm <sup>2</sup>					

Free – cooling, m <sup>3</sup> /hm <sup>2</sup>	
Emission efficiency,%	
Distribution efficiency, %	
Automatic control, %	
Generation efficiency, %	
Fans, occupancy period, W/m <sup>2</sup>	
Fans, non-occupancy period, W/m <sup>2</sup>	
Fans, night cooling, W/m <sup>2</sup>	
Fans, free-cooling, W/m <sup>2</sup>	

## Part 12: Appliances not influencing the thermal balance

	Average			
	simultaneous power	Duration		
Weekdays	W/m <sup>2</sup>	h/day		
Saturdays	W/m <sup>2</sup>	h/day		
Sundays	W/m <sup>2</sup>	h/day		

# PORTUGAL

## I. Building category: Residential buildings

### Subcategory: Social housing (1961 – 1990)

The reference building for a building category/Subcategory can be defined as a building with representative for the building category parameters as follows:

- $\circ \quad \text{Built-up/conditioned area; 65 105 } \text{m}^2$
- Building age; <1990 55,55% 1991 to 2006 39,30% 2007 to 2013 5,15
- Construction materials and corresponding thermal properties of the building envelope;
- Occupancy schedule;
- Technical systems/installations for maintaining the built environment;
- Operational pattern;
- Energy carriers used for heating.

	Building age	Built-up/conditioned area (m <sup>2</sup> )
	<1960	65
Residential	1961 - 1990	70
Buildings	1991 - 2012	95
	>2012	105

	Building	Construction materials - Thermal properties of the building envelope							
	age	WALLS	ROOF	FLOOR	WINDONS				
Single Family	<1960	Ordinary masonry stone wall, plastered on both sides (50 cm) - 2,00	Sloping roof with ceramic tile, lightened slab (15 cm) plastered with 2cm of stucco – 2,80	Tile coating, screed 4 cm, 15 cm lightened slab and ceiling coating cm 2 plaster – 2,10	Single glass with wooden frame – 5,1 Shading device				
	1961- 1990	Single brick wall, brick masonry 22, plastered on both sides (26 cm) - 1,76	Sloping roof with ceramic tile, lightened slab (15 cm) plastered with 2cm of stucco – 2,80	Tile coating, screed 4 cm, 15 cm lightened slab and ceiling coating cm 2 plaster – 2,10	Single glass with metallic frame without thermal cut – 5,2 Shading				
	1991- 2012	Double brick wall, brick masonry 11 + 11 with 3cm of insulation in the air space, plastered on both sides (30 cm) - 0,92	Sloping roof with ceramic tile, lightened slab (15 cm) covered with 3cm of thermal insulation and plastered with 2cm plaster – 0,94	Tile coating, screed 4 cm, 3 cm insulation, lightened slab of 15 cm and ceiling coating cm 2 plaster – 0,78	Single glass with metallic frame without thermal cut – 5,2 Shading				

In residential buildings is assumed that are occupied all days and overall all year (365 days) an the mean internal gains are equal to  $4 \text{ W/m}^2$ 

The *data* obtained from the Energy Performance Certificates *database* of *ADENE*, the Portuguese Energy Agency and managing body for the *National* System for Energy the only technical systems or installations used for maintaining the built environment are, gas heaters or, in the most recent buildings.

### Table PT1: Residential buildings

Building category		Residential Buildings			
Subcategory		1961-1990			
Conditioned area	$m^2$	<b>70</b> Based on internal dimensions, external dimensions or overall internal dimensions			
Conditioned volume	m <sup>3</sup>	70 x 2,7 =			
Climatic zone		Lisbon (Winter: I1; Summer: V2) Z = 109 m			
Part 1: Building (Zone) geometry					
Walls, north	m <sup>2</sup>	<b>19,10</b> Total wall area excl. windows			
Walls, east	m <sup>2</sup>	- Total wall area excl. windows			
Walls, south	m <sup>2</sup>	19,10			

		Total wall area	excl. windows					
Walls, west	m <sup>2</sup>	19, Total wall area	10 excl_windows					
Windows wordt	2	3,5						
Windows, north	m	Window area incl. frames						
Windows, east	m <sup>2</sup>	- Window area	incl. frames					
Windows, south	m <sup>2</sup>	3, Window area	5 incl. frames					
Windows, west	m <sup>2</sup>	3, Window area	5 incl. frames					
Roof	m <sup>2</sup>	70	,0					
Floor	$m^2$	70	,0					
Part 2: Building (Zone) properties								
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,76	Requirement at 2014 Winter Zone I1 / I2 / I3 0,70/ 0,60 / 0,50					
ΔUtb	W/m <sup>2</sup> K	U value	e x 1,35					
b(ground)	-	EN ISO 13370						
b(un-conditioned space)	-	EN ISO 13789,						
b(adjacent sunspace)	-	EN ISO 13789						
b(adjacent building)	m <sup>2</sup>	Default value: 0,6						
Uwindows	W/m <sup>2</sup> K	Prior to investment 5,2	Requirement at 2014 2,9 winter zone: I1					
fraction of the window frame area	%	0,65 - 0,70						
g(F)	-	Total solar energy tran incl. external shading. 0,30	nsmittance for window					
Uroof	W/m <sup>2</sup> K	Prior to investment 2,80	Requirement at 2014 0,50 winter zone: I1					
Ufloor	W/m <sup>2</sup> K	Prior to investment 2,10	Requirement at 2014 0,50 winter zone: I1					
3	-	Emissivity for externative of materials and s Low emissivity or ven Other situations: 0,25	l walls (depending on urface) tilated air gap: 0,10					

α	-	Solar absorption for external walls (depending on colour surface) 0,4-0,5-0,8							
Infiltration, occupancy period	m3/ h.person	Minimum air flow rate expressed in h <sup>-1</sup> Winter: 0,4 Summer: 0,6							
Infiltration, non occupancy	$m^3/h.m^2$	n.a.							
Thermal capacity	Wh/m <sup>2</sup> K	medium expressed in kg/m <sup>2</sup>							
Part 3: Internal gains and operational schedule									
Metabolic heat (occupants)	W/m <sup>2</sup>	(a)							
Latent metabolic heat	W/m <sup>2</sup>	For cooling calculations							
Weekdays	h/day								
Saturdays	h/day								
Sundays	h/day								
Lighting for illumination	DPI (W/m2- 100lux	(a)							
Weekdays	h/day								
Saturdays	h/day								
Sundays	h/day								
Lighting, emergency/controls	W/m <sup>2</sup>	(a)							
Weekdays	h/day								
Saturdays	h/day								
Sundays	h/day								
Appliances	W/m <sup>2</sup>								
Weekdays	h/day								
Saturdays	h/day								
Sundays	h/day								
Latent heat	W/m <sup>2</sup>								
Weekdays	h/day								
Saturdays	h/day								
Sundays	h/day								

(a) residential buildings are assumed that are occupied all days and all over the year (365 days) an the mean internal gains are equal to  $4 \text{ W/m}^2$ .

Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
No. of holidays (excluding weekends)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)		
Part 5: Heating	g mode	-												
Set-point temperature						Duration								
<sup>o</sup> C Weekdays		°C	20		h/da	У	ł	h/day with set-point temperature calculation of heating energy demands						
Saturdays		°C	20		h/da	у			See	above				
Sundays		°C	20		h/da	у			See	above				
Unoccupied period		°C	20						See	above				
Holidays		°C	20						See	above				
Part 6: Heating	g syste	<u>m</u>												
Emission effici	ency				%	% Not installed								
Distribution ef	ficienc	у			%	%								
Automatic con	trol				%	%								
Generation effi	ciency				%									
Energy source	(fuel, e	energy of	carrier)											
Fans/pumps ro	om uni	ts												
Pumps heating	systen	1			W/m <sup>2</sup>									
Pumps pre-hea	ting ve	ntilatio	n		W/m	W/m <sup>2</sup>								
Part 7: Mechai	nical v	entilati	on syste	m (hea	ting ma	<u>ode)</u>								
		1	Supp tempera	oly ature				Dur	ation					
Weekdays		C	°C			h/d	ay			n.a				
Saturdays		0	C			h/d	ay			n.a.				
Sundays		0	C			h/d	ay			n.a				
Ventilation rate	e, occu	pancy p	period, r	m <sup>3</sup> /hm <sup>2</sup>										
Ventilation rate	e, non-	occupa	ncy, m <sup>3</sup> /	′hm²										
Heat recovery	efficie	ncy, %												
Emission efficiency, %														

Distribution efficien	су, %						
Automatic control, 9	%						
Generation efficienc	y, %						
Energy source (fuel,	energy ca	rrier)					
Fans, occupancy per	riod, W/m <sup>2</sup>	2					
Fans, non-occupancy	y period, V	W/m <sup>2</sup>					
Part 8: Domestic ho	ot water sy.	<u>stems</u>					
Quantity			l/m²year	40 l per person per day 40 l x 365 days each person			
Temperature differe	nce		°C	+ 35 °C			
Distribution efficien	юу		%				
Automatic control %	6		%				
Generation efficience	су %		%				
Energy source (fuel,	, energy ca	arrier)	-				
Pumps, DHW system	m		W/m <sup>2</sup>				
Part 9: Cooling mod	<u>le</u>						
Set-point temperature				Duration			
	tempe	rature		Duration			
Weekdays	°C	rature 25	h/day	Duration         h/day with set-point temperature calculation of cooling energy demands         summer period         1 <sup>st</sup> June – 30 <sup>th</sup> September			
Weekdays Saturdays	°C °C	rature 25	h/day h/day	Duration         h/day with set-point temperature calculation of cooling energy demands         summer period         1 <sup>st</sup> June – 30 <sup>th</sup> September         summer period         1 <sup>st</sup> June – 30 <sup>th</sup> September			
Weekdays Saturdays Sundays	°C °C °C	<b>rature</b> 25	h/day h/day h/day	Durationh/day with set-point temperature calculation of cooling energy demandssummer period $1^{st}$ June – $30^{th}$ Septembersummer period $1^{st}$ June – $30^{th}$ Septembersummer period $1^{st}$ June – $30^{th}$ Septembersummer period $1^{st}$ June – $30^{th}$ September			
Weekdays Saturdays Sundays Unoccupied period	°C °C °C °C	<b>rature</b> 25	h/day h/day h/day	Durationh/day with set-point temperature calculation of cooling energy demandsalculation of cooling energy demandssummer period1st June - 30th Septembersummer period1st June - 30th September			
Weekdays Saturdays Sundays Unoccupied period Holidays	°C °C °C °C °C	<b>rature</b> 25	h/day h/day h/day	Durationh/day with set-point temperature calculation of cooling energy demandsall demandssummer period1st June - 30th Septembersummer period1st June - 30th September			
Weekdays Saturdays Sundays Unoccupied period Holidays Part 10: Cooling sys	tempe °C °C °C °C °C °C	<b>rature</b> 25	h/day h/day h/day	Duration         h/day with set-point temperature calculation of cooling energy demands         summer period         1st June – 30th September			
Weekdays Saturdays Sundays Unoccupied period Holidays Emission efficiency	°C °C °C °C stem	rature 25	h/day h/day h/day	Durationh/day with set-point temperature calculation of cooling energy demandssummer period1st June - 30th Septembersummer period1st June - 30th SeptemberNot installed			
Weekdays Saturdays Sundays Unoccupied period Holidays Emission efficiency Distribution efficient	tempe °C °C °C °C °C °C stem	rature           25	h/day h/day h/day	Duration         h/day with set-point temperature calculation of cooling energy demands         summer period         1 <sup>st</sup> June – 30 <sup>th</sup> September         summer period         1 <sup>st</sup> June – 30 <sup>th</sup> September         summer period         1 <sup>st</sup> June – 30 <sup>th</sup> September         summer period         1 <sup>st</sup> June – 30 <sup>th</sup> September         summer period         1 <sup>st</sup> June – 30 <sup>th</sup> September         summer period         1 <sup>st</sup> June – 30 <sup>th</sup> September         summer period         1 <sup>st</sup> June – 30 <sup>th</sup> September         Not installed			

Generation efficiency		%				
Fans/pumps room units			W/m <sup>2</sup>			
Pumps cooling system			W/m <sup>2</sup>			
Part 11: Mechanical ver	ntilation system	ı (coo	oling mode)			
1	Supply emperature		Duration			
Weekdays	°C		h/day		Residential buildings are assumed to be always occupied	
Saturdays	°C		h/day		Residential buildings are assumed to be always occupied	
Sundays	°C		h/day		Residential buildings are assumed to be always occupied	
Ventilation rate, occupan	ncy period, m <sup>3</sup> /	hm²		N		
Ventilation rate, non-occ	supancy, m <sup>3</sup> /hn	1 <sup>2</sup>				
Heat recovery efficiency	, %					
Night - cooling, m3/hm2						
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>						
Emission efficiency,%						
Distribution efficiency,	%					
Automatic control, %						
Generation efficiency, %						
Fans, occupancy period,	W/m <sup>2</sup>					
Fans, non-occupancy per	riod, W/m <sup>2</sup>					
Fans, night cooling, W/n	1 <sup>2</sup>					
Fans, free-cooling, W/m	2					
Part 12: Appliances not	influencing th	e the	rmal balance			
Average simultaneous power			Duration		Duration	
Weekdays	W/m <sup>2</sup>		h/d	ay	n.a.	
Saturdays	W/m <sup>2</sup>		h/d	ay	n.a.	
Sundays	W/m <sup>2</sup>		h/d	ay	n.a	

The residential building legislation concerning the equipment's imposes minimum efficiency requirements on:

Boilers used for space heating where the class minimum efficiency after depending on the year according to the next 2 tables:

Equipmont	Minimum efficiency class after						
Equipment	Entry into force	31 Dec 2015					
Boiler	В	А					

(1) - Class A, where operating temperatures do not permit installation of harnessing the energy released by the condensation of flue gas.

Boilers energy efficiency classes, for space heating, in terms of the nominal efficiency

Energy efficiency class	Nominal efficiency (η)
A+ +	$\eta \ge 96\%$
A +	$96 \% \ge \eta > 92\%$
А	$92 \% \ge \eta > 89\%$
В	$89 \% \ge \eta > 86\%$
С	$86 \% \ge \eta > 83\%$
D	$83 \% \ge \eta > 80\%$
Е	$89 \% \ge \eta > 77\%$
F	η ≤77

**Cooling systems**: minimum efficiency requirements depending on their classification for certification (www.eurovent-certification.com) or performance evaluated by the same reference standard, with the requirement equivalent in terms of COP and EER and the tests should be performed by accredited entity

Air conditioning systems: minimum efficiency requirements depending on their classification for certification (www.eurovent-certification.com) or performance evaluated by the same reference standard, with the requirement equivalent in terms of COP and EER and the tests should be performed by accredited entity

Concerning the renewable energy systems the building code includes guidelines for solar thermal systems, solar photovoltaic systems, micro wind systems, biomass boilers and geothermal systems.

### II Building category: Office/Public administration

#### **Subcategory: Offices**

## **Definition of data**

The reference building for a building category/sub-category can be defined as a building with representative for the building category parameters as follows:

 $\circ$  Built-up/conditioned area; 5705,8 m<sup>2</sup>

- Building age; after 1990
- Construction materials and corresponding thermal properties of the building envelope;
- $\circ~$  1990< Office < 2006, thermal properties of the building envelope corresponding to the national norms of 1990
- Office < 1990 single brick wall or lightweight concrete blocks

Occupancy schedule; 7:00 – 20:00 (weekdays only)

Technical systems/installations for maintaining the built environment;

Operational pattern; 08:00-19:00 (weekdays only)

Energy carriers used for heating: 44 % VRF; 24 % chiller and DHW 75% heater; 21% boiler

### **Data collection**

All necessary data: geometrical, building energy usage, base heat supply regime (type of the heating system, energy resource, etc.) etc., which would allow to perform simulation of the energy consumption, should be collected.

Building category		Offices			
Sub-category		1990< Office < 2006			
Conditioned area	m <sup>2</sup>	<b>5705,8</b> Based on internal dimensions, external dimensions or overall internal dimensions			
Conditioned volume	m <sup>3</sup>	19399,6			
Climatic zone		Lisbon (Winter: I1; Summer: V2) Z = 109 m			
Part 1: Building (Zone) geometry					
Walls, north	m <sup>2</sup>	<b>348,8</b> Total wall area excl. windows			
Walls, east	m <sup>2</sup>	<b>348,8</b> Total wall area excl. windows			
Walls, south	m <sup>2</sup>	<b>348,8</b> Total wall area excl. windows			
Walls, west	m <sup>2</sup>	<b>348,8</b> Total wall area excl. windows			
Windows, north	m <sup>2</sup>	<b>263,2</b> Window area incl. frames			
Windows, east	m <sup>2</sup>	<b>263,2</b> Window area incl. frames			
Windows, south	m <sup>2</sup>	<b>263,2</b> Window area incl. frames			
Windows, west	m <sup>2</sup>	263,2			

 Table PT2: Template for reporting the reference building input data

		Window are	a incl. frames		
Roof	m <sup>2</sup>	1296,0			
Floor	m <sup>2</sup>	12	96,0		
Part 2: Building (Zone) properties					
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,32	Requirement at 2014 Winter Zone I1 / I2 / I3 0,70/ 0,60 / 0,50		
ΔUtb	W/m <sup>2</sup> K	U valu	e x 1,35		
b(ground)	_	Default	value:0,8		
b(un-conditioned space)	-	Default	value:0,8		
b(adjacent sunspace)	-	Default	value:0,8		
b(adjacent building)	m <sup>2</sup>	Default	value:0,6		
Uwindows	W/m <sup>2</sup> K	Prior to investment <b>4,39</b>	Requirement at 2014 0,70 – winter zone: I1		
fraction of the window frame area	%	% 0,57 – 0,90			
g(F)	-	Total solar energy tra incl. external shading.	nsmittance for window 0,45		
Uroof	W/m <sup>2</sup> K	Prior to investment 2,1	Requirement at 2014 0,50 winter zone: I1		
Ufloor	W/m <sup>2</sup> K	Prior to investment 1,65	Requirement at 2014 0,50 winter zone: I1		
3	-	Emissivity for external walls (depending type of materials and surface) Low emissivity or ventilated air gap: 0,10 Other situations: 0.25			
α	-	Solar absorption for external (depending on type of materials and surf $0,4-0,5-0,8$			
Infiltration, occupancy period	m3/h.person	Minimum air flo Office: 20 r	w rate per person m <sup>3</sup> / h.person		
Infiltration, non occupancy	$m^3/h.m^2$	$3 \text{ m}^3$	/h.m <sup>2</sup>		
Thermal capacity	Wh/m <sup>2</sup> K	medium and heavy class according to standard			

Part 3: Internal gains and operational schedule													
Metabolic hea	W	<sup>7</sup> /m²	Ave	Average metabolic heat during the period <b>75</b>			he oper	ation					
Latent metabo	W	7/m²		For cooling calculations									
Weekdays	h/	'day	No 6:0	No. of hours with the metabolic heat normal weekday 6:00- 20 h (with different %: 10%- 10			c heat f	or a 0%)					
Saturdays				h/	'day		0%						
Sundays				h/	'day				0%				
Lighting for il	DPI ( 10	W/m2- Olux	Ave	Average lighting power during the operation period 2,5				ation					
Weekdays				h/	'day	6:0	0- 20 h	(with	differer	nt %: 10	0%-10	0%)	
Saturdays				h/	'day		0%						
Sundays				h/	'day		0%						
Lighting, emergency/controls				W	7/m²	Ave	Average lighting power during the opera period			ation			
Weekdays				h/	'day								
Saturdays				h/	'day								
Sundays				h/	'day								
Appliances				W	//m²	aj	Average simultaneous power from appliances during the operation period 15				od		
Weekdays				h/	'day	6:00- 20 h (with different %: 10%- 100%)							
Saturdays				h/day									
Sundays				h/	'day								
Latent heat				W	<sup>7</sup> /m²	For cooling calculations							
Weekdays				h/	'day								
Saturdays				h/	'day								
Sundays				h/	'day								
<u>Part 4: Holida</u>	<u>ys</u>			<u>.</u>									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
No. of holidays (excluding	1			2	1	1	_	1	_	-	-	2	

weekends)													
Part 5: Heating	<u>mode</u>												
	t	Set-p cemper	oint ature					Duratio	on				
Weekdays	(	°C	20		h/da	y	h	/day wi	ith set-	point te	mperat	ure	
Saturdays	(	°C			h/da	ly		no control					
Sundays	(	°C			h/da	y			no c	ontrol			
Unoccupied period	(	°C							no c	ontrol			
Holidays	(	°C							no c	ontrol			
Part 6: Heating system													
Emission efficiency				%		SF	% PLIT (6:	3,( of equ 3%) -C	)8 iipment HILLE	:: CR (18%	b)		
Distribution eff	ficiency	1			%								
Automatic control				%	%								
Generation efficiency				%									
Energy source (	(fuel, e	nergy c	carrier)		-				electr	ricity			
Fans/pumps roo	om unit	ts			W/m <sup>2</sup>	W/m <sup>2</sup>							
Pumps heating	system	l			W/m <sup>2</sup>	W/m <sup>2</sup>							
Pumps pre-heat	ting vei	ntilatio	n		W/m <sup>2</sup>	W/m <sup>2</sup>							
Part 7: Mechan	<u>ical ve</u>	ntilatio	on syste	em (hea	ting ma	ode)							
		te	Suppl empera	ly ture				Duration					
Weekdays		°C	C			h/da	ay	h	/day w rate (o	ith full ccupane	ventila cy perio	tion od)	
Saturdays		°C	2			h/da	ıy						
Sundays		°C	2			h/da	ny						
Ventilation rate	e, occup	pancy p	eriod, 1	m³/hm²									
Ventilation rate	e, non-c	occupai	ncy, m <sup>3</sup>	/hm²									
Heat recovery e	efficien	cy, %											
Emission efficie	ency, %	6											
Distribution eff	iciency	/, %											
Automatic cont	rol, %												
Generation efficiency, %													

Energy source (fue	el, energy c	carrier)						
Fans, occupancy p	eriod, W/n	n <sup>2</sup>						
Fans, non-occupan	ncy period,	W/m <sup>2</sup>						
Part 8: Domestic h	iot water sy	ystems_						
Quantity			l/m²year	From the legislation default value for small office (<1000 m <sup>2</sup> ) 100 l, all values are accepted including 0 l. There is no specific annual consumption of hot water in the legislation				
Temperature differ	rence		°C	+ 35 °C				
Distribution efficie	ency		%					
Automatic control	%		%					
Generation efficier	ncy %		%	0,93 (storage heater)				
Energy source (fue	el, energy c	arrier)	-	electricity				
Pumps, DHW syste	em		W/m <sup>2</sup>					
Part 9: Cooling mode								
Set-point temperature				Duration				
	<b>.</b>	lavalo						
Weekdays	°C	25	h/day	h/day with set-point temperature				
Weekdays Saturdays	°C °C	25	h/day h/day	h/day with set-point temperature no control				
Weekdays Saturdays Sundays	°C °C °C	25	h/day h/day h/day	h/day with set-point temperature no control no control				
Weekdays Saturdays Sundays Unoccupied period	°C °C °C °C	25	h/day h/day h/day	h/day with set-point temperature no control no control no control				
Weekdays Saturdays Sundays Unoccupied period Holidays	°C °C °C °C °C	25	h/day h/day h/day	h/day with set-point temperature no control no control no control no control				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 9: Cooling sys	°C °C °C °C °C stem	25	h/day h/day h/day	h/day with set-point temperature no control no control no control no control				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 9: Cooling sys Emission efficienc	°C °C °C °C °C stem		h/day h/day h/day	h/day with set-point temperature no control no control no control no control 2,85 % of equipment: SPLIT (61%) -CHILLER (35%)				
Weekdays Saturdays Sundays Unoccupied period Holidays <b>Part 9: Cooling sys</b> Emission efficienc Distribution efficienc	°C °C °C °C °C stem		h/day h/day h/day %	h/day with set-point temperature no control no control no control no control 2,85 % of equipment: SPLIT (61%) -CHILLER (35%)				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 9: Cooling sys Emission efficienc Distribution efficienc Automatic control	°C °C °C °C °C °C stem		h/day h/day h/day % % %	h/day with set-point temperature no control no control no control no control 2,85 % of equipment: SPLIT (61%) -CHILLER (35%)				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 9: Cooling sys Emission efficienc Distribution efficier Automatic control Generation efficier	°C °C °C °C °C stem		h/day h/day h/day % % % %	h/day with set-point temperature no control no control no control no control 2,85 % of equipment: SPLIT (61%) -CHILLER (35%)				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 9: Cooling sys Emission efficienc Distribution efficien Automatic control Generation efficien Fans/pumps room	°C °C °C °C °C stem stem		h/day h/day h/day % % % % % % %	h/day with set-point temperature no control no control no control 2,85 % of equipment: SPLIT (61%) -CHILLER (35%)				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 9: Cooling sys Emission efficienc Distribution efficien Automatic control Generation efficien Fans/pumps room Pumps cooling sys	°C °C °C °C °C stem		h/day h/day h/day % % % % % % % % % % % % % % % % % % %	h/day with set-point temperature no control no control no control 2,85 % of equipment: SPLIT (61%) -CHILLER (35%)				

	Supply temperatu	ire	Duration			
Weekdays	°C		h/day	h/day with full ventilation rate (occupancy period)		
Saturdays	°C		h/day			
Sundays	°C		h/day			
Ventilation rate, occupancy period, m <sup>3</sup> /hm <sup>2</sup>						
Ventilation rate, non-	occupancy,	, m³/hm²				
Heat recovery efficient	ncy, %					
Night - cooling, m <sup>3</sup> /h	m <sup>2</sup>					
Free - cooling, m <sup>3</sup> /hn	n²					
Emission efficiency,%	6					
Distribution efficienc	y, %					
Automatic control, %						
Generation efficiency	r, %					
Fans, occupancy period	od, W/m²					
Fans, non-occupancy	period, W/	m²				
Fans, night cooling, W	W/m²					
Fans, free-cooling, W	//m²					
Part 11: Appliances n	ot influen	cing the th	ermal balance			
	A <sup>s</sup> simu p	verage Iltaneous oower		Duration		
Weekdays	V	W/m²	h/day			
Saturdays	1	W/m <sup>2</sup>	h/day			
Sundays	V	W/m <sup>2</sup>	h/day			

# ROMANIA

According to the analysis of the public building stock in Romania (from inventory of existing buildings owned and occupied by central administration and adding estimated building data from local public administration – mainly offices and schools), the biggest share, in terms of total floor area and primary energy consumption, is represented by office buildings (30% of total floor area and 36% of total primary energy consumption) and by educational buildings (56% of total floor area and 51% of total primary energy consumption).

One reference building has been selected for each of these building categories, taking into consideration the average characteristics (total floor area, shape, thermal characteristics, use and primary energy). One should note that the building stock data did not permit the detailed definition

of a virtual building (average statistical characteristics), but facilitated the choice of existing buildings which are similar to the average performance of the considered building categories in the public building stock.

The two defined reference buildings are presented in Table RO 1 and Table RO 2, detailing the necessary data which would allow performing simulation of the energy consumption (geometrical, building energy usage, base heat supply etc.).

## I. Building category: Offices/Public administration

#### **Subcategory: Central authorities**

- Average characteristics from the analysis of public building stock:
- Total built-up area: 2,352 m<sup>2</sup>,
- Useful area of conditioned space: 2,074 m<sup>2</sup>,
- Land area occupied by the building: 707 m<sup>2</sup>,
- Average number of floors: GF + 3,6 Levels
- Construction materials concrete + light cellular concrete blocks; thermal properties of the building envelope corresponding to existing public building stock,
- $\circ$  Occupancy schedule 10 h/day 5 days/week,
- Technical systems: central heating with two options:
  - a) based on natural gas burning water heating boiler
  - b) based on district heating.

#### Table RO 1: Offices/Public administration, Central authorities – Administrative Buildings

Building category		OFFICES/PUBLIC ADMINISTRATION				
Subcategory		Central authorities – Administrative Building				
Conditioned area	$m^2$	1,872 (overall internal dimensions)				
Conditioned volume	m <sup>3</sup>	5,275 (net conditioned volume)				
Climatic zone		Climatic zone II City: Bucharest				
Part 1: Building (Zone) geometry						
Walls, north	m <sup>2</sup>	188,58				
Walls, east	m <sup>2</sup>	127,85				
Walls, south	m <sup>2</sup>	188,58				
Walls, south-west	m <sup>2</sup>	-				
Walls, west	m <sup>2</sup>	127,60				
Walls, north-west	m <sup>2</sup>					
Windows, north	m <sup>2</sup>	239,7				
Windows, east	m <sup>2</sup>	71,6				

Windows, south	m <sup>2</sup>	239,7				
Windows, west	m <sup>2</sup>	71	,6			
Windows, north-west	m <sup>2</sup>		·			
Roof	$m^2$	375	5,00			
Floor	m <sup>2</sup>	375,00				
Walls adjacent to staircase	m <sup>2</sup>	856,56				
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,586	Requirement at 2014 0,625			
ΔUtb	W/m <sup>2</sup> K	0,11 (include	d in U-value)			
b(ground)	-	calcu	lated			
b(un-conditioned space)	-	calcu	lated			
b(adjacent sunspace)	-	-	-			
b(adjacent building)	_	calcu	lated			
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,564	Requirement at 2014 2,0			
fraction of the window frame area	%	taken into account in Uwindow and g				
g(F)	-	0,6	576			
Uroof (to the external air)	W/m <sup>2</sup> K	Prior to investment Requirement at 1,127 0,25				
Ufloor (to unheated basement)	W/m <sup>2</sup> K	Prior to investment 3,074	Requirement at 2014 0,43			
3	-	0.	,9			
α	-	0.	,6			
Infiltration, occupancy period	$h^{-1}$	1,	08			
Infiltration, non occupancy	h <sup>-1</sup>	1,	08			
Thermal capacity	Wh/m <sup>2</sup> K	73.	,91			
Part 3: Internal gains and operation	nal schedule					
Metabolic heat (occupants)	W/m <sup>2</sup>	13	,28			
Latent metabolic heat	W/m <sup>2</sup>	(	)			
Weekdays	h/day	1	0			
Saturdays	h/day	(	)			
Sundays	h/day	(	)			
Lighting for illumination	W/m <sup>2</sup>	4	,7			
Weekdays	h/day	9	)			
Saturdays	h/day	(	)			

Sundays	Sundays				h/day			0						
Lighting, en	nergenc	y/contro	ols		W/m <sup>2</sup>				2,	5				
Weekdays					h/day				24	ł				
Saturdays					h/day	24								
Sundays					h/day 24									
Appliances					W/m <sup>2</sup>				9,2	2				
Weekdays					h/day				1(	)				
Saturdays					h/day				0					
Sundays					h/day				0					
Latent heat					$W/m^2$				0					
Weekdays					h/day				0					
Saturdays					h/day				0					
Sundays					h/day				0					
<u>Part 4: Hol</u>	<u>idays</u>													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
No. of holidays (excluding weekends)	2	0	0	1	1	1	0	1	0	0	1	3		
Part 5: Hea	ting ma	ode												
	Set-point				Duration									
		tem	peratu	re				Dura	ation					
Weekdays		tem °C	peratu	re 20	h	ı/day		Dura	ation	10				
Weekdays Saturdays		°C °C	peratu	re 20 12	h h	ı∕day ı∕day		Dura	ation	10 24				
Weekdays Saturdays Sundays		tem °C °C °C	peratu	re 20 12 12	h h h	ı/day ı/day ı/day		Dura	ation	10 24 24				
Weekdays Saturdays Sundays Unoccupied period		tem °C °C °C	peratu	<b>re</b> 20 12 12 12 12	k k k	u/day u/day u/day		Dura	ation	10 24 24				
Weekdays Saturdays Sundays Unoccupied period Holidays		tem     °C     °C     °C     °C	peratu	re           20           12           12           12           12           12	h h h	ı/day ı/day ı/day		Dura	ation	10 24 24				
Weekdays Saturdays Sundays Unoccupied period Holidays <b>Part 6: Hea</b>	ting sys	tem           °C           °C           °C           °C           °C           °C		re       20       12       12       12       12       12	h h h	ı/day ı/day ı/day		Dura	ation	10 24 24				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 6: Hea Emission eff	ting sys	tem °C °C °C °C stem		re 20 12 12 12 12 12 12	       	ı/day ı/day ı/day		Dura	ation	10 24 24 97				
Weekdays Saturdays Sundays Unoccupied period Holidays <b>Part 6: Hea</b> Emission eff Distribution	ting sys	tem °C °C °C °C stem		re 20 12 12 12 12 12		//day //day //day //day				10 24 24 97 98,2				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 6: Hea Emission eff Distribution Automatic co	ting sys	tem °C °C °C °C stem cy		re 20 12 12 12 12 12 12		//day //day //day //day //day		Dura		10 24 24 97 98,2 92				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 6: Hea Emission eff Distribution Automatic co	ting sys ficiency efficiency ontrol	tem °C °C °C °C stem cy		re 20 12 12 12 12 12		//day //day/		Dura		10 24 24 97 98,2 92 100				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 6: Head Emission eff Distribution Automatic cod Generation e	ting system iciency efficiency ontrol efficiency ce (fuel,	tem °C °C °C °C °C stem cy	carrier)	re 20 12 12 12 12 12 12		//day //day/			Distr	10 24 24 97 98,2 92 100 ict heati				
Weekdays Saturdays Sundays Unoccupied period Holidays Part 6: Head Emission eff Distribution Automatic co Generation e Energy source Fans/pumps	ting system iciency efficiency ontrol fficienc ce (fuel, room ur	tem °C °C °C °C °C stem cy	carrier)	re 20 12 12 12 12 12		//day //day			Distr	10 24 24 97 98,2 92 100 ict heati 0				

Pumps pre-heating	ventilation			W/m <sup>2</sup>	2 0		
Part 7: Mechanic	al ventilati	on system	(heatin	ng mode)			
	1	Supply temperatu	re		D	uration	
Weekdays	с	°C 2	20	h/da	y	10	
Saturdays	C	C		h/day		-	
Sundays	С	C		h/da	-		
Ventilation rate, oc	cupancy per	riod, m <sup>3</sup> /hm <sup>2</sup>	2			-	
Ventilation rate, no	ventilation rate, non-occupancy, m3/hm2					-	
Heat recovery effic	iency, %					n/a	
Emission efficiency	v, %					-	
Distribution efficient	ncy, %					-	
Automatic control,	%					-	
Generation efficien	су, %					-	
Energy source (fuel	l, energy car	rrier)				-	
Fans, occupancy pe	eriod, W/m <sup>2</sup>					-	
Fans, non-occupancy period, W/m <sup>2</sup>						-	
Part 8: Domestic	<u>hot water s</u>	<u>systems</u>					
Quantity				l/m²year		115	
Temperature different	ence			°C		40	
Distribution efficient	ncy			%	80		
Automatic control	%			%		100	
Generation efficien	су %			%		80	
Energy source (fuel	l, energy car	rtier)		-		District heating	
Pumps, DHW syste	em			W/m <sup>2</sup>		0	
Part 9: Cooling m	<u>node</u>						
	Set-j tempe	point rature			Dura	ation	
Weekdays	°C	26		h/day		10	
Saturdays	°C	29		h/day		24	
Sundays	°C	29		h/day		24	
Unoccupied period	°C	29				_	
Holidays	°C	29				-	
Part 10: Cooling	<u>system</u>						

Emission efficiency			%	% 100				
Distribution efficiency			%		100			
Automatic control			%		100			
Generation efficiency			%	250				
Fans/pumps room units	/pumps room units			-				
Pumps cooling system			W/m <sup>2</sup>	-				
Part 11: Mechanical v	entilation s	ystem (co	ooling mode)					
	Supply temperature			Duration				
Weekdays	°C	26	h/da	у	-			
Saturdays	°C		h/da	у	-			
Sundays	°C		h/day	у	-			
Ventilation rate, occupar	ncy period, n	n <sup>3</sup> /hm <sup>2</sup>		- -				
Ventilation rate, non-occ	cupancy, m <sup>3</sup> /	hm²			-			
Heat recovery efficiency	, %				n/a			
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>					n/a			
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>					n/a			
Emission efficiency,%				-				
Distribution efficiency, 9	%			-				
Automatic control, %					-			
Generation efficiency, %	)				-			
Fans, occupancy period,	W/m <sup>2</sup>				-			
Fans, non-occupancy per	riod, W/m <sup>2</sup>				-			
Fans, night cooling, W/n	n <sup>2</sup>				n/a			
Fans, free-cooling, W/m <sup>2</sup>	2				n/a			
Part 12: Appliances no	ot influenci	ng the th	ermal balance					
	Aver	rage ous power			Duration			
Weekdays	4,5 V	V/m <sup>2</sup>	h/da	У	24			
Saturdays	4,5 V	V/m <sup>2</sup>	h/da	у	24			
Sundays	4,5 V	V/m <sup>2</sup>	h/da	у	24			

# II. Building category: Educational buildings

## Subcategory: Schools

 $\circ$   $\;$  Average characteristics from the analysis of public building stock:

- Total built-up area: 2,660 m<sup>2</sup>,
- Useful area of conditioned space: 2,294 m<sup>2</sup>,
- Land area occupied by the building: 1,021 m<sup>2</sup>,
- $\circ$  Average number of floors: GF + 2,2 Levels
- Construction materials concrete + masonry; thermal properties of the building envelope corresponding to existing educational building stock,
- $\circ$  Occupancy schedule 13 h/day 5 days/week,
- Technical systems: central heating with two options:
  - a) based on natural gas burning water heating boiler
  - b) based on district heating.

#### Table RO 2: Educational buildings, Schools

Building category		EDUCATIONAL BUILDINGS						
Subcategory		Scl	hool					
Conditioned area	m <sup>2</sup>	1857,6 (overall in	nternal dimensions)					
Conditioned volume	m <sup>3</sup>	6470 (net cond	itioned volume)					
Climatic zone		Climatic zone II	City: Bucharest					
Part 1: Building (Zone) geometry								
Walls, north-west	m <sup>2</sup>	35	6,61					
Walls, north-east	m <sup>2</sup>	20	0,46					
Walls, south-east	m <sup>2</sup>	44	1,41					
Walls, south-west	$m^2$	20	1,31					
Windows, north-west	m <sup>2</sup>	54,72						
Windows, north-east	m <sup>2</sup>	54,24						
Windows, south-east	$m^2$	21	1,20					
Windows, south-west	$m^2$	53	3,52					
Roof	m <sup>2</sup>	71	3,63					
Floor	m <sup>2</sup>	71	3,63					
Walls adjacent to staircase	m <sup>2</sup>	35	1,96					
Part 2: Building (Zone) properties								
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,927	Requirement at 2014 0,625					
ΔUtb	W/m <sup>2</sup> K	0,40 (include	ed in U-value)					
b(ground)	-	calcu	ılated					
b(un-conditioned space)	-	calcu	ılated					
b(adjacent sunspace)	-		-					
b(adjacent building)	$m^2$	calcu	ılated					

Uwindows	W/m <sup>2</sup> K	Prior to investment 2,564 Requirement at 20 1,45			
fraction of the window frame area	%	taken into account	in Uwindows and g		
g(F)	-	0,6	576		
Uroof (to external air)	W/m <sup>2</sup> K	Prior to investment 1,342	Requirement at 2014 0,22		
Ufloor (to unheated basement)	W/m <sup>2</sup> K	Prior to investment 2,929	Requirement at 2014 0,43		
3	-	0	,9		
α	-	0	,6		
Infiltration, occupancy period	$\mathbf{h}^{-1}$	0,	35		
Infiltration, non occupancy	$\mathbf{h}^{-1}$	0,	35		
Thermal capacity	Wh/m <sup>2</sup> K	73	,91		
Part 3: Internal gains and operation	onal schedule				
Metabolic heat (occupants)	W/m <sup>2</sup>	16	i,06		
Latent metabolic heat	W/m <sup>2</sup>	n/a			
Weekdays	h/day	-			
Saturdays	h/day	-			
Sundays	h/day		-		
Lighting for illumination	W/m <sup>2</sup>	7	7,5		
Weekdays	h/day		9		
Saturdays	h/day		0		
Sundays	h/day		0		
Lighting, emergency/controls	W/m <sup>2</sup>	0	,66		
Weekdays	h/day		24		
Saturdays	h/day		24		
Sundays	h/day		24		
Appliances	W/m <sup>2</sup>	7	7,5		
Weekdays	h/day	-	13		
Saturdays	h/day		0		
Sundays	h/day		0		
Latent heat	W/m <sup>2</sup>	r	n/a		
Weekdays	h/day		-		
Saturdays	h/day		-		
Sundays	h/day		-		

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
No. of holidays (excluding weekends)	5	5	0	7	1	12	23	20	10	0	1	9		
Part 5: Heat	ting mo	ode_												
		Se temj	t-point peratur	e		Duration								
Weekdays		°C	2	0	h/	day		13						
Saturdays		°C	1	2	h/	day				24				
Sundays		°C	1	2	h/	day				24				
Unoccupied period		°C	1	2										
Holidays		°C	1	2										
Part 6: Heat	ting sys	<u>stem</u>												
Emission eff	iciency				%	, D			(	€7				
Distribution	efficien	су			%	, D			9	8,2				
Automatic co	ontrol				% 92									
Generation e	fficienc	у			%	, D			1	00				
Energy source	e (fuel,	el, energy carrier)			-				Distric	t heating	5			
Fans/pumps	room ui	n units			W/	m <sup>2</sup>				0				
Pumps heating	ng syste	m			W/	m <sup>2</sup>			0	,55				
Pumps pre-h	eating v	entilatio	n		W/	W/m <sup>2</sup> 0								
Part 7: Mec	hanica	l ventila	tion sys	stem (h	eating n	<u>node)</u>								
			Suj tempe	pply erature	•			Du	ration					
Weekdays			°C	20		h	/day			13				
Saturdays			°C			h	/day			-				
Sundays			°C			h	/day			-				
Ventilation r	ate, occ	upancy p	eriod, n	n³/hm²					2,9					
Ventilation ra	ate, non	-occupai	ncy, m <sup>3</sup> /l	1m²					-					
Heat recover	y efficie	ency, %							n/a					
Emission eff	iciency,	%							-					
Distribution	efficien	су, %							-					
Automatic co	ontrol, 9	6							-					
Generation e	fficienc	y, %							-					

Energy source (fuel,	energy carr	ier)				-		
Fans, occupancy peri	iod, W/m <sup>2</sup>					-		
Fans, non-occupancy	v period, W	/m²				-		
Part 8: Domestic h	ot water sy	<u>ystems</u>						
Quantity			]	l/m²year	year 91,3			
Temperature differen	nce			°C		40		
Distribution efficiency				%		80		
Automatic control %				%		100		
Generation efficiency %				%		80		
Energy source (fuel,	energy carr	rier)		-		District heating		
Pumps, DHW system	n			W/m <sup>2</sup>		0		
Part 9: Cooling mode								
	Set-j tempe	point rature		Duration				
Weekdays	°C	26		h/day		13		
Saturdays	°C	29		h/day		24		
Sundays	°C	29		h/day	h/day 24			
Unoccupied period	°C	29						
Holidays	°C	29				-		
Part 10: Cooling sy	v <u>stem</u>							
Emission efficiency				%	6 100			
Distribution efficience	cy			%		100		
Automatic control				%		100		
Generation efficiency	ý			%		250		
Fans/pumps room un	its			W/m <sup>2</sup>		-		
Pumps cooling system	m			W/m <sup>2</sup>				
Part 11: Mechanic	al ventilati	ion systen	n (coo	<u>ling mode)</u>				
	Supply tempe	y rature				Duration		
Weekdays	°C	2	26	h/day	y	1	3	
Saturdays	°C			h/day	y		-	
Sundays	°C			h/day	y		-	
Ventilation rate, occu	upancy peri	od, m <sup>3</sup> /hm	2			2,9		
Ventilation rate, non-occupancy, m <sup>3</sup> /hm <sup>2</sup>				_				

Heat recovery effic	iency, %	n/a				
Night – cooling, m <sup>3</sup>	/hm²		n/a			
Free – cooling, m <sup>3</sup> /l	hm²	n/a				
Emission efficiency	/,%	-				
Distribution efficient	ncy, %	-				
Automatic control,	%		-			
Generation efficient	су, %		-			
Fans, occupancy pe	priod, W/m <sup>2</sup>		-			
Fans, non-occupant	ey period, W/m <sup>2</sup>	-				
Fans, night cooling,	, W/m²	n/a				
Fans, free-cooling,	W/m <sup>2</sup>	n/a				
Part 12: Applianc	es not influencing the the	rmal balance				
	Average simultaneous power	D	uration			
Weekdays	4,5 W/m <sup>2</sup>	h/day	24			
Saturdays	4,5 W/m <sup>2</sup>	h/day 24				
Sundays	4,5 W/m <sup>2</sup>	h/day	24			

## **SLOVENIA**

### **Definition of data**

The reference buildings for a building category/subcategory are defined as a building with representative for the building category parameters as follows:

- Total net floor conditioned area;
- Building age;
- Construction materials and corresponding thermal properties of the building envelope;
- Occupancy schedule: according to the category, several are proposed;

For the purpose of this work, all reference buildings have the same climate conditions with a default location – Ljubljana, characterized by 3,300 heating degree days. The lowest average temperature in Ljubljana is  $-1^{\circ}$ C in January, the highest is in July –  $20^{\circ}$ C (Table SI 1). The average yearly temperature is 9,7°C. The design outdoor temperature for sizing the heating systems is  $-13^{\circ}$ C in the heating season (depends on the location within the country). The number of hours of sunshine for Ljubljana is between 1800 and 1900 hours per year, the global horizontal radiation is 1121 kWh/m2a.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	°C	-1	1	6	10	15	18	20	19	15	10	4	1
Relative humidity	%	82	77	72	71	73	72	75	76	80	82	84	85
Radiation	kWh/m <sup>2</sup> a	917	1731	2759	4049	4894	5274	5469	4739	3354	1911	983	698

Table SI 1: Monthly climatic data for Ljubljana (ARSO[5])

Reference building was formed in two steps. At first the average values of indicators were identified and in the end, a real building was found that correlates the best to the average values and is a potential for a renovation.

BUILDING TYPE	CLIMAT IC ZONE	PERIOD OF CONSTUCTI ON	CONDITION ED FLOOR AREA [m2]	SHAPE FACTOR [m(-1)]	SHARE OF THE GLAZING
Office/Public	Ljubljana	1980	1300	0,43	8 %
Kindergarten	Ljubljana	1983	1170	0,66	8 %
School	Ljubljana	1982	2290	0,44	11 %
Health-care	Ljubljana	1967	2220	0,50	10 %
Social housing	Ljubljana	1978	4489	0,33	13 %

 Table SI1: Observed public building categories through indicators

According to the upper table:

- Thermal envelope from buildings built between 1980 and 1983 is going to correspond thermal properties based on the Regulation from 1980;
- Thermal envelope from buildings built in 1978 is going to correspond thermal properties based on the Regulation from 1970;
- Thermal envelope from buildings built in 1967 is going to correspond thermal properties based on the Regulation from 1963;
- The most commonly used energy carriers in public buildings are natural gas and district heating, hence both will be used in further analyses.

To gather all the necessary data in order to form reference buildings, next sources of information were used:

- Register of EPC,
- Register of Real Estates,
- Survey of energy efficiency on non-residential building (REUS).

Based on the characteristics of the reference buildings indicators, real public buildings have been chosen as a representative for its category.

#### **Data collection**

The main conclusions of the analysis of the five selected representative building categories are as follows:

### I. Building category: Offices/Public administration

#### **Subcategory: Central authorities – Administrative buildings**

- Construction materials concrete + masonry; thermal properties of the building envelope corresponding to the national norms of 1980,
- Occupancy schedule:
  - a) 8 h/day 5 days/week,
  - b) 12 h/day 5 days/week,

- Technical systems: central heating with three options:
  - a) Low-temperature gas boiler
  - b) District heating

# Table SI2: Offices/Public administration

Building category		OFFICES/PUBLIC ADMINISTRATION				
Sub-category		Central authorities – Administrative Building				
Conditioned area	m <sup>2</sup>	1299 (intern	al dimensions)			
Conditioned volume	m <sup>3</sup>	3769 (ne	et volume)			
Climatic zone		Ref. number: 1	City: Ljubljana			
Part 1: Building (Zone) geometry						
Walls, north	m <sup>2</sup>	23	31,0			
Walls, east	$m^2$	10	09,0			
Walls, south	$m^2$	23	37,0			
Walls, west	$m^2$	12	23,0			
Windows, north	m <sup>2</sup>		33			
Windows, east	$m^2$	2	43			
Windows, south	$m^2$	27				
Windows, west	$m^2$	2	27			
Roof	$m^2$	430,0				
Floor	$m^2$	430,0				
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment 0,8	Requirement at 2014 0,28			
Uwalls (to the terrain)	W/m <sup>2</sup> K	Prior to investment 0,8	Requirement at 2014 0,35			
ΔUtb	W/m <sup>2</sup> K					
b(ground)	-					
b(un-conditioned space)	-					
b(adjacent sunspace)	-					
b(adjacent building)	m <sup>2</sup>					
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,8	Requirement at 2014 1,3			
fraction of the window frame area	%	taken into account in Uwindow and g				
g(F)	-	0,60				
Uroof (to the external air)	W/m <sup>2</sup> K	Prior to investment	Requirement at 2014			

		0,6	0,20				
Ufloor (to the external air)	W/m <sup>2</sup> K	Prior to investment 1,0	Requirement at 2014 0,30				
ε	-	0,9					
α	-		0,6				
Infiltration, occupancy period (fixed)	$h^{-1}$		0,5				
Infiltration, non-occupancy (fixed)	$h^{-1}$		0,5				
Infiltration, occupancy period (wind driven flow, 50 Pa pressure difference)	$h^{-1}$		3,5				
Infiltration, non-occupancy (wind driven flow, 50 Pa pressure difference)	$\mathbf{h}^{-1}$	3,5					
Thermal capacity	Wh/m <sup>2</sup> K		130				
Part 3: Internal gains and operation	nal schedule						
Sensible heat gains	W/m <sup>2</sup>		6,0				
Latent metabolic heat	W/m <sup>2</sup>		0				
Weekdays	h/day	8;12					
Saturdays	h/day	0					
Sundays	h/day	0					
Lighting for illumination	W/m <sup>2</sup>						
Weekdays	h/day	8	; 12				
Saturdays	h/day		0				
Sundays	h/day		0				
Lighting, emergency/controls	W/m <sup>2</sup>						
Weekdays	h/day						
Saturdays	h/day						
Sundays	h/day						
Appliances	W/m <sup>2</sup>	3,0					
Weekdays	h/day	8	; 12				
Saturdays	h/day		0				
Sundays	h/day		0				
Latent heat	W/m <sup>2</sup>	0					
Weekdays	h/day	8	; 12				
Saturdays	h/day		0				
Sundays	h/day	0					

Part 4: Holidays													
	Jan	Feb	Mar	Apr	May	May Jun Jul Aug Sep Oct Nov					Dec		
No. of holidays (excluding weekends)	1	1	0	2	2	0	0	0	0	1	1	2	
Part 5: Heating mode													
Set-point temperature						Duration							
Weekdays		°C	2	20	h/o	day				8;12			
Saturdays		°C	2	20	h/o	day				0			
Sundays		°C	2	20	h/o	day				0			
Unoccupied p	eriod	°C	2	20									
Holidays		°C	2	20									
<u>Part 6: Heati</u>	ng sys	<u>tem</u>											
Emission efficiency				%	% 96								
Distribution ef	fficienc	сy			%	% 95							
Automatic cor	ntrol				%	% 85							
Generation eff	ficiency	Y			%	% 80							
Energy source	(fuel,	energy c	arrier)		-	- Natural gas/district heating							
Fans/pumps ro	oom un	its			W/1	W/m <sup>2</sup>							
Pumps heating	g systei	n			W/1	W/m <sup>2</sup>							
Pumps pre-hea	ating v	entilation	1		W/1	m²							
<u>Part 7: Mech</u>	anical	l ventila	tion sys	stem (he	eating n	<u>10de)</u>							
			Sup tempe	oply rature				Dı	uration				
Weekdays			°C			h/d	lay						
Saturdays			°C			h/day							
Sundays			°C				lay	у					
Ventilation rat	te, occi	ipancy p	eriod, m	<sup>3</sup> /hm <sup>2</sup>									
Ventilation rate, non-occupancy, m3/hm2			1m <sup>2</sup>										
Heat recovery efficiency, %													
Emission efficiency, %													
Distribution efficiency, %													
Automatic control, %													
Generation efficiency													
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Energy source (fuel, e	energy carri	er)											
Fans, occupancy period													
Fans, non-occupancy	period, W/r	n²											
Part 8: Domestic ho	et water sys	<u>stems</u>											
Specific daily energy	consumptic	on		l/(m <sup>2</sup> year)	)	30							
Temperature differen	ce			°C		30							
Distribution efficienc	у			%		95							
Automatic control %				%									
Generation efficiency	%			%		95							
Energy source (fuel, e	energy carri	er)				Natural gas/district heating							
Pumps, DHW system				W/m <sup>2</sup>		0,3							
Part 9: Cooling mod	<u>le</u>												
Set-point temperature						Duration							
Weekdays	°C	26		h/day		9							
Saturdays	°C	26		h/day		24							
Sundays	°C	26		h/day		24							
Unoccupied period	°C	26											
Holidays	°C	26											
Part 10: Cooling sys	stem												
Emission efficiency				%									
Distribution efficienc	у			%									
Automatic control				%									
Generation efficiency				%									
Fans/pumps room uni	.ts			W/m <sup>2</sup>									
Pumps cooling system	n			W/m <sup>2</sup>									
Part 11: Mechanica	l ventilatio	on system	n (coo	oling mode)									
Supply temperature						Duration							
Weekdays	°C			h/da	ıy								
Saturdays	°C			h/da	y								
Sundays	°C			h/da	ıy								
Ventilation rate, occu	pancy perio	d, m³/hm	l <sup>2</sup>										
Ventilation rate, non-occupancy, m3/hm2													

Heat recovery efficiency	, %		
Night - cooling, m3/hm2			
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>			
Emission efficiency,%			
Distribution efficiency,	%		
Automatic control, %			
Generation efficiency, %	)		
Fans, occupancy period,	W/m <sup>2</sup>		
Fans, non-occupancy per	riod, W/m <sup>2</sup>		
Fans, night cooling, W/n	n <sup>2</sup>		
Fans, free-cooling, W/m	2		
Part 12: Appliances no	ot influencing the the	rmal balance	
	Average simultaneous power		Duration
Weekdays		h/day	
Saturdays		h/day	

### **II.Building category: Kindergarten**

• Construction materials – concrete + masonry; thermal properties of the building envelope – corresponding to the national norms of 1980,

h/day

• Occupancy schedule:

Sundays

- a) 8 h/day 5 days/week,
- b) 12 h/day 5 days/week,
- Technical systems: central heating with two options:
  - a) Low-temperature gas boiler
  - b) District heating

#### Table SI3: Kindergarten

Building category		EDUCATIONAL BUILDINGS				
Sub-category		Kindergarten				
Conditioned area	m <sup>2</sup>	1520 (internal dimensions)				
Conditioned volume	m <sup>3</sup>	4644 (net volume)				
Climatic zone		Ref. number: 1 City: Ljubljana				
Part 1: Building (Zone) geometry						
Walls, north	m <sup>2</sup>	373,45				
Walls, east	$m^2$	184,27				

Walls, south	m <sup>2</sup>	1:	58,38			
Walls, west	m <sup>2</sup>	253,24				
Windows, north	m <sup>2</sup>	25,62				
Windows, east	m <sup>2</sup>	14	49,95			
Windows, south	m <sup>2</sup>	5	51,77			
Windows, west	m <sup>2</sup>	ç	07,54			
Roof	m <sup>2</sup>		896			
Floor	m <sup>2</sup>		656			
Floor above basement	m <sup>2</sup>		240			
Doors	m <sup>2</sup>		47			
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment 0,8	Requirement at 2014 0,28			
Uwalls (to the terrain)	W/m <sup>2</sup> K	Prior to investment 0,8	Requirement at 2014 0,35			
ΔUtb	W/m <sup>2</sup> K					
b(ground)	-					
b(un-conditioned space)	-					
b(adjacent sunspace)	-					
b(adjacent building)	m <sup>2</sup>					
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,8	Requirement at 2014 1,3			
fraction of the window frame area	%	taken into accour	nt in Uwindow and g			
g(F)	-		0,60			
Uroof (to the external air)	W/m <sup>2</sup> K	Prior to investment 0,6	Requirement at 2014 0,20			
Ufloor (to the external air)	W/m <sup>2</sup> K	Prior to investment 1,0	Requirement at 2014 0,30			
3	-		0,9			
α	-		0,6			
Infiltration, occupancy period (fixed)	$h^{-1}$		0,5			
Infiltration, non-occupancy (fixed)	$h^{-1}$	0,5				
Infiltration, occupancy period (wind driven flow, 50 Pa pressure difference)	$\mathbf{h}^{-1}$	3,5				
Infiltration, non-occupancy (wind driven flow, 50 Pa pressure difference)	$h^{-1}$		3,5			

Thermal capac	ity			Wh	/m <sup>2</sup> K	130							
Part 3: Intern	al gai	ns and o	peratio	nal sch	hedule								
Sensible heat g	gains			,	W/m <sup>2</sup>		6,0						
Latent metabolic heat					W/m <sup>2</sup>		0						
Weekdays				]	h/day					8;12	2		
Saturdays				]	h/day		0						
Sundays				]	h/day					0			
Lighting for ill	lumina	tion		,	W/m <sup>2</sup>								
Weekdays				]	h/day					8;12	2		
Saturdays				]	h/day					0			
Sundays				]	h/day					0			
Lighting, emer	gency/	controls/		,	W/m <sup>2</sup>								
Weekdays				]	h/day								
Saturdays				]	h/day								
Sundays				]	h/day								
Appliances				,	W/m <sup>2</sup>		1,0						
Weekdays				]	h/day		8;12						
Saturdays				]		0							
Sundays				]	h/day		0						
Latent heat				,	W/m <sup>2</sup>					0,0			
Weekdays				]					8;12	2			
Saturdays				]		0							
Sundays				]	h/day					0			
Part 4: Holidd	<u>ays</u>												
	Jan	Feb	Mar	Apr	May	Jun	Jı	ıl	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	1	1	0	2	2 2		C	)	0	0	1	1	2
Part 5: Heatin	ng mo	de											
Set-point													
temperature				e					Dura	uon			
Weekdays		°C	2	0	h/e	day				8	3;12		
Saturdays		°C	2	0	h/o	day					0		
Sundays		°C	2	0	h/o	day	0						

Unoccupied period	°C	20							
Holidays	°C	20							
Part 6: Heating sys	tem				<u>_</u>				
Emission efficiency				%		96			
Distribution efficienc	У			%		95			
Automatic control				%		85			
Generation efficiency	7			%		80			
Energy source (fuel, o	energy carrie	er)		-		Natural gas/district heating			
Fans/pumps room un	its			W/m <sup>2</sup>					
Pumps heating system	n			W/m <sup>2</sup>					
Pumps pre-heating ve	entilation			W/m <sup>2</sup>					
Part 7: Mechanical	ventilation	n system	(heati	ing mode)					
	te	Supply mperat	y ure			Duration			
Weekdays	°C			h/d	ay				
Saturdays	°C			h/d	ay				
Sundays	°C			h/d	ay				
Ventilation rate, occu	pancy perio	d, m³/hm	1 <sup>2</sup>						
Ventilation rate, non-	occupancy,	m <sup>3</sup> /hm <sup>2</sup>							
Heat recovery efficient	ncy, %								
Emission efficiency,	%								
Distribution efficienc	y, %								
Automatic control, %									
Generation efficiency	, %								
Energy source (fuel, e	energy carrie	er)							
Fans, occupancy peri-	od, W/m²								
Fans, non-occupancy	period, W/n	n <sup>2</sup>							
Part 8: Domestic ho	ot water sys	<u>tems</u>							
Specific daily energy	consumptio	n		l/(m <sup>2</sup> year)		170			
Temperature difference				°C	°C 30				
Distribution efficienc	У			%		95			
Automatic control %				%	%				
Generation efficiency	/ %			%	% 95				
Energy source (fuel, e	energy carrie	er)		-		Natural gas/district heating			
Pumps, DHW system				W/m <sup>2</sup>	0,3				

Part 9: Cooling mo	<u>ode</u>							
	Set-j tempe	ooint rature			Dı	uration		
Weekdays	°C	26		h/day		9		
Saturdays	°C	26		h/day		24		
Sundays	°C	26		h/day		24		
Unoccupied period	°C	26						
Holidays	°C	26						
Part 10: Cooling sy	ystem_							
Emission efficiency				%				
Distribution efficiend	су			%				
Automatic control				%				
Generation efficienc	у			%				
Fans/pumps room un	nits			W/m <sup>2</sup>				
Pumps cooling system				W/m <sup>2</sup>				
Part 11: Mechanic	al ventilat	ion syst	em (coo	oling mode)				
	Supp temp	ly erature		Duration				
Weekdays	°(	C		h/da	ıy			
Saturdays	°(	C		h/da	ıy			
Sundays	°(	C		h/da	ıy			
Ventilation rate, occ	upancy per	iod, m <sup>3</sup> /h	m <sup>2</sup>					
Ventilation rate, non	-occupancy	, m³/hm	2					
Heat recovery efficie	ency, %							
Night – cooling, m <sup>3</sup> /	hm²							
Free – cooling, m <sup>3</sup> /h	m <sup>2</sup>							
Emission efficiency,	%							
Distribution efficient	су, %							
Automatic control, %	6							
Generation efficiency, %								
Fans, occupancy per	iod, W/m <sup>2</sup>							
Fans, non-occupancy	y period, W	/m <sup>2</sup>						
Fans, night cooling,	W/m <sup>2</sup>							
Fans, free-cooling, W/m <sup>2</sup>								

Part 12: Appliances not influencing the thermal balance							
	Average simultaneous power		Duration				
Weekdays		h/day					
Saturdays		h/day					
Sundays		h/day					

## **III.Building category: School**

- Construction materials concrete + masonry; thermal properties of the building envelope corresponding to the national norms of 1980,
- Occupancy schedule:
  - a) 8 h/day 5 days/week,
  - b) 12 h/day 5 days/week,
- Technical systems: central heating with two options:
  - a) Low-temperature gas boiler
  - b) District heating

#### Table SI4: School

Building category		EDUCATIONAL BUILDINGS					
Sub-category		School					
Conditioned area	m <sup>2</sup>	3125 (internal dimensions)					
Conditioned volume	m <sup>3</sup>	13367 (net volume)					
Climatic zone		Ref. number: 1 City: Ljubljana					
Part 1: Building (Zone) geometry		•					
Walls, north	$m^2$	356,4					
Walls, east	m <sup>2</sup>	507,1					
Walls, south	m <sup>2</sup>	297,0					
Walls, west	m <sup>2</sup>	488,7					
Windows, north	m <sup>2</sup>	114,56					
Windows, east	m <sup>2</sup>	264,44					
Windows, south	m <sup>2</sup>	124,82					
Windows, west	m <sup>2</sup>	273,73					
Roof	m <sup>2</sup>	1472					
Roof, inclined 15°, west	m <sup>2</sup>	40,67					
Roof, inclined 15°, east	m <sup>2</sup>	40,67					
Floor	m <sup>2</sup>	1637					
Doors	$m^2$	5,65					

Part 2: Building (Zone) properties					
Uwalls	W/m <sup>2</sup> K	Prior to investment 0,8	Requirement at 2014 0,28		
Uwalls (to the terrain)	W/m <sup>2</sup> K	Prior to investment 0,8	Requirement at 2014 0,35		
ΔUtb	W/m <sup>2</sup> K				
b(ground)	-				
b(un-conditioned space)	-				
b(adjacent sunspace)	-				
b(adjacent building)	$m^2$				
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,8	Requirement at 2014 1,3		
fraction of the window frame area	%	taken into accour	nt in Uwindow and g		
g(F)	-		0,60		
Uroof (to the external air)	W/m <sup>2</sup> K	Prior to investment 0,6	Requirement at 2014 0,20		
Ufloor (to the external air)	W/m <sup>2</sup> K	Prior to investment 1,0	Requirement at 2014 0,30		
3	-		0,9		
α	-	0,6			
Infiltration, occupancy period (fixed)	$h^{-1}$		0,5		
Infiltration, non-occupancy (fixed)	$h^{-1}$		0,5		
Infiltration, occupancy period (wind driven flow, 50 Pa pressure difference)	$h^{-1}$		3,5		
Infiltration, non-occupancy (wind driven flow, 50 Pa pressure difference)	$\mathbf{h}^{-1}$		3,5		
Thermal capacity	Wh/m <sup>2</sup> K		145		
Part 3: Internal gains and operatio	nal schedule				
Sensible heat gains	W/m <sup>2</sup>		6,0		
Latent metabolic heat	W/m <sup>2</sup>		0		
Weekdays	h/day	3	3;12		
Saturdays	h/day		0		
Sundays	h/day		0		
Lighting for illumination	W/m <sup>2</sup>				
Weekdays	h/day	8	3;12		

Saturdays					h	n/day		0							
Sundays					h	n/day				0					
Lighting, eme	rgency/	controls	1		Ι	W/m²									
Weekdays					h	n/day									
Saturdays					h	n/day									
Sundays					h	n/day									
Appliances					V	W/m²				1,0					
Weekdays					h	n/day				8;1	2				
Saturdays					h	n/day				0					
Sundays					h	n/day				0					
Latent heat					V	W/m²				0,0					
Weekdays					h	n/day				8;1	2				
Saturdays					h	n/day				0					
Sundays					h	n/day				0					
Part 4: Holid	ays_														
	Jan	Feb	Ma	r A	pr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
No. of holidays (excluding weekends)	1	1	0		2	2	0	0	0	0	1	1	2		
Part 5: Heati	ng moo	<u>de</u>									<u>.</u>				
		Set	t-poin Derat	nt ure	Duration										
Weekdays		°C		20		h/	day	v 8 · 12							
Saturdays		°C		20		h/	day				0				
Sundays		°C		20		h/	day				0				
Unoccupied pe	eriod	°C		20	_										
Holidays		°C		20											
Part 6: Heati	ng syst	<u>em</u>													
Emission efficiency						%			96						
Distribution efficiency						%					95				
Automatic control						%					85				
Generation eff	ficiency					%		80							
Energy source	(fuel, e	energy ca	arrier)	)		-			Natı	ural gas/	district	heating			
Fans/pumps room units						W/m	2								

Pumps heating system			W/m <sup>2</sup>				
Pumps pre-heating v	entilation			W/m <sup>2</sup>			
Part 7: Mechanica	l ventilatio	on system	(heati	ing mode)			
	t	Supply emperatu	ire	Duration			
Weekdays	°(	С		h/da	ıy		
Saturdays	°(	С		h/da	ıy		
Sundays	°(	С		h/da	ıy		
Ventilation rate, occ	upancy per	iod, m <sup>3</sup> /hm	2 <sup>2</sup>				
Ventilation rate, non	-occupancy	/, m <sup>3</sup> /hm <sup>2</sup>					
Heat recovery efficie	ency, %						
Emission efficiency,	%						
Distribution efficient	су, %						
Automatic control, 9	6						
Generation efficienc	y, %						
Energy source (fuel,	energy car	rier)					
Fans, occupancy per	iod, W/m <sup>2</sup>						
Fans, non-occupancy	y period, W	//m²					
Part 8: Domestic h	ot water s	<u>ystems</u>					
Specific daily energy	y consumpt	ion		l/(m <sup>2</sup> year)		500	
Temperature differen	nce			°C		30	
Distribution efficient	су			%		95	
Automatic control %	)			%			
Generation efficienc	у %			%		95	
Energy source (fuel,	energy car	rier)		-		Natural gas/district heating	
Pumps, DHW system	n			W/m <sup>2</sup>		0,3	
Part 9: Cooling mo	<u>ode</u>						
Set-point temperature					-	Duration	
Weekdays	°C	26		h/day		9	
Saturdays	°C	26		h/day		24	
Sundays	°C	26		h/day		24	
Unoccupied period	°C	26					
Holidays	°C	26					

Part 10: Cooling system	<u>n</u>				
Emission efficiency			%		
Distribution efficiency			%		
Automatic control			%		
Generation efficiency			%		
Fans/pumps room units			W/m <sup>2</sup>		
Pumps cooling system			W/m <sup>2</sup>		
Part 11: Mechanical ve	entilation syst	tem (coo	oling mode)		
	Supply temperature				Duration
Weekdays	°C		h/da	ıy	
Saturdays	°C		h/da	ıy	
Sundays	°C		h/da	ıy	
Ventilation rate, occupant	cy period, m <sup>3</sup> /ł	nm²			<u>,                                     </u>
Ventilation rate, non-occu	upancy, m <sup>3</sup> /hm	2			
Heat recovery efficiency,	%				
Night – cooling, m <sup>3</sup> /hm <sup>2</sup>					
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>					
Emission efficiency,%					
Distribution efficiency, %	, )				
Automatic control, %					
Generation efficiency, %					
Fans, occupancy period,	W/m <sup>2</sup>		-		
Fans, non-occupancy peri	iod, W/m <sup>2</sup>				
Fans, night cooling, W/m <sup>2</sup>					
Fans, free-cooling, W/m <sup>2</sup>					
Part 12: Appliances not	<u>t influencing</u>	the the	rmal balance		
	Averag simultaneous	ge s power			Duration

Weekdays	h/day	
Saturdays	h/day	
Sundays	h/day	

## **IV.Building category: Health-care facilities**

- Construction materials concrete + masonry; thermal properties of the building envelope corresponding to the national norms of 1980,
- Occupancy schedule:

- a) 8 h/day 5 days/week,
- b) 12 h/day 5 days/week,
- c) 8 h/day 7 days/week,
- d) 12 h/day 7 days/week
- Technical systems: central heating with two options:
  - a) Low-temperature gas boiler
  - b) District heating

#### **Table SI5: Health-care facilities**

Building category		HEALTH-CARE FACILITY				
Sub-category		Но	ospital			
Conditioned area	m <sup>2</sup>	3144 (internal dimensions)				
Conditioned volume	m <sup>3</sup>	12035 (1	net volume)			
Climatic zone	•	Ref. number: 1	City: Ljubljana			
Part 1: Building (Zone) geometry		-				
Walls, north	m <sup>2</sup>	14	13,14			
Walls, east	m <sup>2</sup>	39	91,25			
Walls, south	m <sup>2</sup>	18	37,24			
Walls, west	m <sup>2</sup>	1	90,8			
Wall against the terrain	m <sup>2</sup>	1	152,8			
Windows, north	m <sup>2</sup>	72,36				
Windows, east	m <sup>2</sup>	7	6,56			
Windows, south	m <sup>2</sup>	8	3,76			
Windows, west	m <sup>2</sup>	187,2				
Roof	$m^2$	1	822			
Floor	m <sup>2</sup>	1606,8				
Doors	m <sup>2</sup>	5	54,8			
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,2	Requirement at 2014 0,28			
Uwalls (to the terrain)	W/m <sup>2</sup> K	Prior to investment 1,2	Requirement at 2014 0,35			
ΔUtb	W/m <sup>2</sup> K					
b(ground)	-					
b(un-conditioned space)	-					
b(adjacent sunspace)	-					
b(adjacent building)	$m^2$					

Uwindows	W/m <sup>2</sup> K	Prior to investment 2,3	Requirement at 2014 1,3	
fraction of the window frame area	%	taken into accoun	t in Uwindow and g	
g(F)	-	(	),60	
Uroof (to the external air)	W/m <sup>2</sup> K	Prior to investment 1,2	Requirement at 2014 0,20	
Ufloor (to the external air)		Prior to investment 1,4	Requirement at 2014 0,30	
3	- W/m <sup>2</sup> K		0,9	
α	-		0,6	
Infiltration, occupancy period (fixed)	$h^{-1}$		0,5	
Infiltration, non-occupancy (fixed)	$\mathbf{h}^{-1}$		0,5	
Infiltration, occupancy period (wind driven flow, 50 Pa pressure difference)	$h^{-1}$		3,5	
Infiltration, non-occupancy (wind driven flow, 50 Pa pressure difference)	$h^{-1}$	3,5		
Thermal capacity	Wh/m <sup>2</sup> K	90		
Part 3: Internal gains and operation	nal schedule			
Sensible heat gains	W/m <sup>2</sup>		6,0	
Latent metabolic heat	W/m <sup>2</sup>		0	
Weekdays	h/day	8;1	2;8;12	
Saturdays	h/day	0;0	); 8; 12	
Sundays	h/day	0;0	); 8; 12	
Lighting for illumination	W/m <sup>2</sup>			
Weekdays	h/day	8;1	2;8;12	
Saturdays	h/day	0;0	); 8; 12	
Sundays	h/day	0;0	); 8; 12	
Lighting, emergency/controls	W/m <sup>2</sup>			
Weekdays	h/day			
Saturdays	h/day			
Sundays	h/day			
Appliances	W/m <sup>2</sup>		3,0	
Weekdays	h/day	8;1	2;8;12	
Saturdays	h/day	0;0	); 8; 12	
Sundays	h/day	0;0	); 8; 12	

Latent heat					W/m <sup>2</sup>		0,0						
Weekdays					h/day		8;12;8;12						
Saturdays					h/day		0;0;8;12						
Sundays					h/day		0;0;8;12						
Part 4: Holid	ays_												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
No. of holidays (excluding weekends)	1	1	0	2	2	0	0	0	0	1	1	2	
<u>Part 5: Heati</u>	ng mo	<u>ode</u>											
		Set temp	-point eratur	e				Dura	tion				
Weekdays		°C	2	2	h/d	lay			8;	12;8;1	2		
Saturdays		°C	22	2	h/d	lay		0;0;8;12					
Sundays		°C	2	2	h/d	lay		0;0;8;12					
Unoccupied period		°C	2:	2									
Holidays		°C	2	2									
Part 6: Heati	ng sys	<u>tem</u>											
Emission effic	iency				%			96					
Distribution ef	ficienc	су			%			95					
Automatic con	ntrol				%			85					
Generation eff	ficiency	/			%			80					
Energy source	(fuel,	energy ca	arrier)		-			Nat	ural gas	/district	heating		
Fans/pumps ro	om un	its			W/r	n²							
Pumps heating	g syster	n			W/r	n²	_						
Pumps pre-hea	ating vo	entilation	l		W/ı	n²							
Part 7: Mech	anical	l ventilat	tion sys	tem (h	eating n	<u>iode)</u>							
			Suj tempe	pply crature	2			Dı	uration	1			
Weekdays			°C			h/	day						
Saturdays			°C			h/	day						
Sundays			°C			h/	day						
Ventilation rat	e, occi	ipancy pe	eriod, m	³/hm²									

Ventilation rate, non-	occupancy,	m³/hm²		
Heat recovery efficiency, %				
Emission efficiency, %				
Distribution efficiency, %				
Automatic control, %	1			
Generation efficiency	/, %			
Energy source (fuel,	energy carri	er)		
Fans, occupancy peri	od, W/m²			
Fans, non-occupancy	period, W/	m <sup>2</sup>		0
Part 8: Domestic he	ot water sy	<u>stems</u>		
Specific daily energy	consumpti	on	l/(m <sup>2</sup> year)	530
Temperature differen	ce		°C	30
Distribution efficience	y		%	95
Automatic control %			%	
Generation efficiency	/ %		%	95
Energy source (fuel, energy carrier)			-	Natural gas/district heating
Pumps, DHW system			W/m <sup>2</sup>	0,3
Part 9: Cooling mo	<u>de</u>			
	Set-p tempe	ooint rature		Duration
Weekdays	°C	26	h/day	9
Saturdays	°C	26	h/day	24
	0.9			2.
Sundays	°C	26	h/day	24
Sundays Unoccupied period	°C °C	26 26	h/day	24
Sundays Unoccupied period Holidays	°C °C °C	26 26 26	h/day	24
Sundays Unoccupied period Holidays Part 10: Cooling sy	°C °C °C stem	26 26 26	h/day	24
Sundays Unoccupied period Holidays Part 10: Cooling sy Emission efficiency	°C °C stem	26 26 26	h/day %	24
Sundays Unoccupied period Holidays <b>Part 10: Cooling sy</b> Emission efficiency Distribution efficience	°C °C stem	26 26 26	h/day % %	
Sundays Unoccupied period Holidays <b>Part 10: Cooling sy</b> Emission efficiency Distribution efficience Automatic control	°C °C stem	26 26 26	h/day	
Sundays Unoccupied period Holidays <b>Part 10: Cooling sy</b> Emission efficiency Distribution efficiency Automatic control Generation efficiency	°C °C stem y	26 26 26	h/day	
Sundays Unoccupied period Holidays <b>Part 10: Cooling sy</b> Emission efficiency Distribution efficiency Automatic control Generation efficiency Fans/pumps room un	°C °C stem sy	26 26 26	h/day	
Sundays Unoccupied period Holidays <b>Part 10: Cooling sy</b> Emission efficiency Distribution efficiency Automatic control Generation efficiency Fans/pumps room un Pumps cooling syster	°C °C stem sy	26 26 26	h/day ///////////////////////////////////	
Sundays Unoccupied period Holidays <b>Part 10: Cooling sy</b> Emission efficiency Distribution efficiency Automatic control Generation efficiency Fans/pumps room un Pumps cooling syster <b>Part 11: Mechanica</b>	°C °C stem stem '' '' its n ul ventilati	26 26 26 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	h/day % % % % W/m <sup>2</sup> W/m <sup>2</sup>	

Weekdays	°C		h/day	
Saturdays	°C		h/day	
Sundays	°C		h/day	
Ventilation rate, occupancy	y period, m <sup>a</sup>	³/hm²		
Ventilation rate, non-occup	pancy, m <sup>3</sup> /h	m <sup>2</sup>		
Heat recovery efficiency, 9	%			
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>				
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>				
Emission efficiency,%				
Distribution efficiency, %				
Automatic control, %				
Generation efficiency, %				
Fans, occupancy period, W	//m²			
Fans, non-occupancy perio	od, W/m²			
Fans, night cooling, W/m <sup>2</sup>				
Fans, free-cooling, W/m <sup>2</sup>				

# Part 12: Appliances not influencing the thermal balance

	Average simultaneous power		Duration
Weekdays		h/day	
Saturdays		h/day	
Sundays		h/day	

## V.Building category: Social housing

- Construction materials concrete + masonry; thermal properties of the building envelope corresponding to the national norms of 1980,
- Occupancy schedule:
  - a) 24 h/day 5 days/week,
  - b) 24 h/day 7 days/week,
- Technical systems: central heating with two options:
  - a) Low-temperature gas boiler
  - b) District heating

#### Table SI6: Home for elderly people

Building category		RESIDENTIAL		
Sub-category		Social housing		
Conditioned area	$m^2$	4633 (internal dimensions)		

Conditioned volume	m <sup>3</sup>	12923 (net volume)			
Climatic zone		Ref. number: 1	City: Ljubljana		
Part 1: Building (Zone) geometry		•			
Walls, north	m <sup>2</sup>	192,15			
Walls, east	$m^2$		622		
Walls, south	m <sup>2</sup>		134,6		
Walls, west	m <sup>2</sup>		591,3		
Windows, north	$m^2$		72,85		
Windows, east	$m^2$		264		
Windows, south	$m^2$		112,4		
Windows, west	$m^2$		298,7		
Roof	$m^2$		512		
Roof against the unheated space	$m^2$		920		
Floor	$m^2$		1432		
Doors	$m^2$	12			
Part 2: Building (Zone) properties					
Uwalls	W/m <sup>2</sup> K	Prior to investment 0,8	Requirement at 2014 0,28		
Uwalls (to the terrain)	W/m <sup>2</sup> K	Prior to investment 0,8	Requirement at 2014 0,35		
ΔUtb	W/m <sup>2</sup> K				
b(ground)	-				
b(un-conditioned space)	-				
b(adjacent sunspace)	-				
b(adjacent building)	m <sup>2</sup>				
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,8	Requirement at 2014 1,3		
fraction of the window frame area	%	taken into accou	int in Uwindow and g		
g(F)	-		0,60		
Uroof (to the external air)	W/m <sup>2</sup> K	Prior to investment 0,6	Requirement at 2014 0,20		
Ufloor (to the external air)	W/m <sup>2</sup> K	Prior to investment 1,0	Requirement at 2014 0,30		
ε	-		0,9		
α	-		0,6		
Infiltration, occupancy period (fixed)	$\mathbf{h}^{-1}$		0,5		

Infiltration, no (fixed)	iltration, non-occupancy xed)						0,5							
Infiltration, or driven flow difference)	Infiltration, occupancy period (wind driven flow, 50 Pa pressure difference)				h <sup>-1</sup>		3,5							
Infiltration, no (wind driven difference)	Infiltration, non-occupancy (wind driven flow, 50 Pa pressure difference)					h <sup>-1</sup> 3,5								
Thermal capac	city			Wł	n/m <sup>2</sup> K				211					
Part 3: Inter	nal gair	ns and	operatio	onal sci	<u>hedule</u>									
Sensible heat	gains			1	W/m²				6,0					
Latent metabo	olic heat	t		V	W/m²				0					
Weekdays				ł	n/day				24;2	24				
Saturdays				ł	n/day				0;2	4				
Sundays				ł	n/day				0;2	4				
Lighting for i	Lighting for illumination													
Weekdays	Weekdays						24;24							
Saturdays	Saturdays				h/day			0;24						
Sundays				ł	n/day		0;24							
Lighting, eme	ergency/	controls	1	V	W/m²									
Weekdays				ł	h/day									
Saturdays				ł	h/day									
Sundays				ł	n/day									
Appliances				V	W/m²		2,0							
Weekdays				ł	n/day		24;24							
Saturdays				ł	n/day		0;24							
Sundays				ł	n/day		0;24							
Latent heat				V	W/m²				0					
Weekdays				ł	n/day		24;24							
Saturdays				ł	n/day				0;2	4				
Sundays	ndays				n/day				0;2	4				
Part 4: Holid	<u>lays</u>													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
No. of holidays (excluding weekends)	1	1	0	2	2	0	0	0	0	1	1	2		

Part 5: Heating mode								
	Set-point temperature			Duration				
Weekdays	°C	20	h/day	24;24				
Saturdays	°C	20	h/day	0;24				
Sundays	°C	20	h/day	0;24				
Unoccupied period	°C	20						
Holidays	°C	20						
Part 6: Heating system								
Emission efficiency			%	96				
Distribution efficience	cy		%	95				
Automatic control			%	85				
Generation efficiency	/		%	80				
Energy source (fuel,	energy carri	er)	-	Natural gas/district heating				
Fans/pumps room un	its		W/m <sup>2</sup>					
Pumps heating syster	n		W/m <sup>2</sup>					
Pumps pre-heating ventilation		W/m <sup>2</sup>						
Part 7: Mechanical	ventilation	n system (	heating mode)					
		Supply						

	Su tempe	pply erature	Duration				
Weekdays	°C		h/day				
Saturdays	°C		h/day				
Sundays	°C		h/day				
Ventilation rate, occupancy	y period, m	<sup>3</sup> /hm <sup>2</sup>					
Ventilation rate, non-occup	pancy, m <sup>3</sup> /h	1m <sup>2</sup>					
Heat recovery efficiency, 9	%						
Emission efficiency, %							
Distribution efficiency, %							
Automatic control, %							
Generation efficiency, %							
Energy source (fuel, energy	y carrier)						
Fans, occupancy period, W	//m²						
Fans, non-occupancy perio	od, W/m <sup>2</sup>						
Part 8: Domestic hot wa	ter system	<u>s</u>					

Specific daily energy consumption				l/(m <sup>2</sup> year)	1/(m <sup>2</sup> year) 450			
Temperature different	ce			°C		30		
Distribution efficienc	у			%		95		
Automatic control %				%				
Generation efficiency	, %			%		95		
Energy source (fuel, e	energy ca	rrier)		-	- Natural gas/district he			
Pumps, DHW system	l			W/m <sup>2</sup>	W/m <sup>2</sup> 0,3			
Part 9: Cooling mo	<u>de</u>							
	Set-point				D (:			
	temj	oeratu	re		Duration			
Weekdays	°C	2	.6	h/day		9		
Saturdays	°C	2	6	h/day		24		
Sundays	°C	2	.6	h/day		24		
Unoccupied period	°C	2	.6					
Holidays	°C	2	.6					
Part 10: Cooling sy	<u>stem</u>							
Emission efficiency				%				
Distribution efficienc	у			%				
Automatic control				%				
Generation efficiency	7			%				
Fans/pumps room uni	its			W/m <sup>2</sup>				
Pumps cooling system	n			W/m <sup>2</sup>				
Part 11: Mechanica	il ventild	tion sy	ostem (co	ooling mode)				
	Suten	oply operatur	e		Duration			
Weekdays		°C		h/da	7			
Saturdays		°C		h/da	7			
Sundays		°C		h/da	7			
Ventilation rate, occu	pancy pe	riod, m	³/hm²					
Ventilation rate, non-	occupan	≿y, m³/h	m <sup>2</sup>					
Heat recovery efficient	ncy, %							
Night - cooling, m <sup>3</sup> /h	m <sup>2</sup>							
Free – cooling, m <sup>3</sup> /hn	n²							
Emission efficiency,%	6							
Distribution efficienc	y, %							

Automatic control, %			
Generation efficiency, %			
Fans, occupancy period, V	W/m <sup>2</sup>		
Fans, non-occupancy peri-	od, W/m²		
Fans, night cooling, W/m <sup>2</sup>	2		
Fans, free-cooling, W/m <sup>2</sup>			
Part 12: Appliances not	t influencing the ther	mal balance	
	Average simultaneous power		Duration
Weekdays		h/day	
Saturdays		h/day	
Sundays		h/day	

## SPAIN, CATALONIA

The main conclusions of the analysis of the two selected representative building categories are as follows:

## I. Building category: Offices/Public administration

#### Subcategory: Regional authorities

- The reference building should have built-up area more than 5000 m2,
- Construction materials: the building should be constructed between 1980 and 2006. Thermal properties of the building envelope – corresponding to 1st energy regulation for buildings (NBE-CT-79),
- $\circ$  Occupancy schedule 12 h/day 5 days/week,
- Technical systems: electrical heat pump.

#### Table SP1: Office/Public Administration, Regional authorities

Building category		Office/Public Administration				
Subcategory		Regional authorities				
Conditioned area	m <sup>2</sup>	7899,85				
Conditioned volume	m <sup>3</sup>	19749,63				
	Climatic zone	Ref. number: C2 City: Barcelona				
		Part 1: Building (Zone) geometry				
Walls, N	m <sup>2</sup>	570				
Walls, NE	m <sup>2</sup>	240,6				
Walls, NO		560,99				
Walls, SE_1	m <sup>2</sup>	84,93				

Walls, SE	m <sup>2</sup>	621,3				
Windows, N	m <sup>2</sup>	37	2,70			
Windows, NE	m <sup>2</sup>	89	9,28			
Windows, NO	m <sup>2</sup>	274	4,83			
Windows, SE	m <sup>2</sup>	40	)2,9			
Roof	m <sup>2</sup>	9	21			
Floor	m <sup>2</sup>	23	337			
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment Façade: 1,98/ Back wall 2,77	Requirement at 2014 0,75			
ΔUtb	W/m <sup>2</sup> K					
b(ground)	-					
b(un-conditioned space)	-					
b(adjacent sunspace)	-					
b(adjacent building)	$m^2$					
Uwindows	W/m <sup>2</sup> K	Prior to investment 3,3/5,7	Requirement at 2014 3,1			
fraction of the window frame area	%	0,3				
g(F)	-	0,75/0,82				
Uroof	W/m <sup>2</sup> K	Prior to investment 2,27	Requirement at 2014 0,5			
Ufloor	W/m <sup>2</sup> K	Prior to investment 2,61	Requirement at 2014 0,7			
3	-	0	,9			
α	-	0	,6			
Infiltration, occupancy period	$h^{-1}$	0,	28			
Infiltration, non occupancy	$h^{-1}$	0,	28			
Thermal capacity	Wh/m <sup>2</sup> K					
Part 3: Internal gains and operation	nal schedule					
Metabolic heat (occupants)	W/m <sup>2</sup>	4	.,37			
Latent metabolic heat	W/m <sup>2</sup>	4	.,37			
Weekdays	h/day		12			
Saturdays	h/day		0			
Sundays	h/day		0			
Lighting for illumination	W/m <sup>2</sup>	11,90				

Weekdays				1	h/day		12					
Saturdays					h/day		0					
Sundays				1	h/day				0			
Lighting, emergency/controls					W/m <sup>2</sup>							
Weekdays					h/day							
Saturdays				1	n/day							
Sundays				1	h/day							
Appliances				1	W/m²				18,35	i		
Weekdays				1	h/day				12			
Saturdays				1	h/day				0			
Sundays				1	h/day				0			
Latent heat				1	W/m <sup>2</sup>							
Weekdays				1	h/day							
Saturdays				1	h/day				0			
Sundays				1	h/day				0			
Part 4: Holidays												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	1	0	1	2	0	2	0	1	2	0	1	5
Part 5: Heatin	ig mo	<u>de</u>					<u>.</u>	<u>.</u>		<u></u>	<u>.</u>	
		Set-p temper	ooint rature				Duration					
Weekdays		°C	21		h/da	у				12		
Saturdays		°C			h/da	y						
Sundays		°C			h/da	y						
Unoccupied period		°C										
Holidays		°C										
Part 6: Heatin	ig syst	tem_										
Emission effici	ency				%		94					
Distribution eff	ficienc	у			%				9	9		
Automatic cont	rol				%							
Generation effi	ciency				%				2,84 (	(COP)		
Energy source (	(fuel, e	energy car	rrier)		-				elect	ricity		

Fans/pumps room un	its		V	W/m <sup>2</sup>			
Pumps heating syster	n		V	W/m <sup>2</sup>			
Pumps pre-heating ve	entilation		V	W/m <sup>2</sup>			
Part 7: Mechanical	l ventilatio	n system (	(heatin	g mode)			
	te	Supply emperature	re	Duration			
Weekdays	°C			h/da	ay	13	
Saturdays	°C	2		h/da	ay		
Sundays	°C	2		h/da	ay		
Ventilation rate, occu	pancy perio	od, m <sup>3</sup> /hm <sup>2</sup>				2,62	
Ventilation rate, non-	-occupancy	, m³/hm²					
Heat recovery efficie	ncy, %						
Emission efficiency,	%						
Distribution efficience	cy, %						
Automatic control, %							
Generation efficiency							
Energy source (fuel,	ier)				electricity		
Fans, occupancy period, W/m <sup>2</sup>							
Fans, non-occupancy	period, W/	m <sup>2</sup>					
Part 8: Domestic he	ot water sy	<u>stems</u>					
Quantity				l/m²year n.a.			
Temperature differen	ice			°C			
Distribution efficience	су			%			
Automatic control %				%			
Generation efficiency	y %			%			
Energy source (fuel,	energy carr	ier)		-			
Pumps, DHW system	1			W/m <sup>2</sup>			
Part 9: Cooling mo	<u>de</u>		<u> </u>				
	Set-j tempe	point rature				Duration	
Weekdays	°C	25		h/day		12	
Saturdays	°C			h/day			
Sundays	°C			h/day			
Unoccupied period	°C						
Holidays	°C						

Part 10: Cooling syste	m						
Emission efficiency			%		97		
Distribution efficiency			%		99		
Automatic control		%					
Generation efficiency			%		2,59 (EER)		
Fans/pumps room units			W/m <sup>2</sup>				
Pumps cooling system		W/m <sup>2</sup>					
Part 11: Mechanical	ventilation s	ystem (co	oling mode)				
Supply temperature			Duration				
Weekdays	°C		h/day		13		
Saturdays	°C		h/day				
Sundays	°C		h/day				
Ventilation rate, occupancy period, m <sup>3</sup> /hm <sup>2</sup>				2	2,62		
Ventilation rate, non-oc	cupancy, m <sup>3</sup> /	hm²					
Heat recovery efficiency	/, %						
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>							
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>							
Emission efficiency,%							
Distribution efficiency,	%						
Automatic control, %							
Generation efficiency, %	6						
Fans, occupancy period,	$W/m^2$						
Fans, non-occupancy pe	eriod, W/m <sup>2</sup>						
Fans, night cooling, W/n	m²						
Fans, free-cooling, W/m	1 <sup>2</sup>						
Part 12: Appliances n	ot influenci	ing the the	ermal balance				
	A simulta	Average aneous pow	ver	I	Duration		
Weekdays	1,	84 W/m <sup>2</sup>	h/c	day	12		
Saturdays		W/m <sup>2</sup>	h/c	lay			
Sundays		W/m <sup>2</sup>	h/day				

# II. Building category: Health-care facilities Subcategory: Hospitals

• The reference building should have built-up area should be higher than 10 000 m2,

- Construction materials: the building should be constructed between 1980 and 2006. Thermal properties of the building envelope – corresponding to 1st energy regulation for buildings (NBE-CT-79).
- $\circ$  Occupancy schedule 24 h/day 7 days/week
- Technical systems:
  - a) Natural gas boilers
  - b) Electric chillers

#### Table ES2: Health-care facilities, Hospitals

Building category		Health-care	facilities				
Subastagowy		Hospitals					
	<u>1</u>	Hospitals					
Conditioned area	$m^2$	142	254,00				
Conditioned volume	m <sup>3</sup>	356	535,00				
Climatic zone		Ref. number: B3 City: Tarragona					
Part 1: Building (Zone) geometry		-					
Walls, north	m <sup>2</sup>	134	436,46				
Walls, east	$m^2$	56	61,25				
Walls, south	$m^2$	133	316,65				
Walls, west	$m^2$	50	59,03				
Windows, north	m <sup>2</sup>	347,70					
Windows, east	$m^2$	55,31					
Windows, south	$m^2$	228,71					
Windows, west	$m^2$	51,29					
Roof	$m^2$	1543,00					
Floor	$m^2$	25	48,00				
Part 2: Building (Zone) properties							
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,277	Requirement at 2014 1				
ΔUtb	W/m <sup>2</sup> K						
b(ground)	-						
b(un-conditioned space)	-						
b(adjacent sunspace)	-						
b(adjacent building)	$m^2$						
Uwindows	W/m <sup>2</sup> K	Prior to investment Requirement at 2 3,69/2,85 4,2					
fraction of the window frame area	%	0,3					
g(F)	-	0,7	5/0,8				

Uroof				W	/m <sup>2</sup> K		Pri	or to inv 2,21	vestmen 5	t	Require	ment at 0,65	2014	
Ufloor				W	/m <sup>2</sup> K		Pri	or to inv 2,6	vestmen 1	t	Require	ment at	2014	
3		-					0,9							
α					-					0,6				
Infiltration, occ	ifiltration, occupancy period									0,28				
Infiltration, nor	1 occupa	ıncy		j	$h^{-1}$					0,28				
Thermal capaci	ity			Wh	/m <sup>2</sup> K									
Part 3: Internal gains and operational schedu														
Metabolic heat (occupants)					W/m²					6,33				
Latent metabol	lic heat			1	W/m <sup>2</sup>					6,47	1			
Weekdays				1	h/day					24				
Saturdays				]	h/day					24				
Sundays				]	h/day					24				
Lighting for ill		W/m <sup>2</sup>		5,70										
Weekdays	1	h/day					11							
Saturdays				1	h/day	11								
Sundays				]	h/day	11								
Lighting, emer	ting, emergency/controls				W/m <sup>2</sup>									
Weekdays	days			1	h/day									
Saturdays	aturdays			1	h/day									
Sundays				1	h/day									
Appliances					W/m <sup>2</sup>					5,82				
Weekdays				1	h/day					24				
Saturdays				1	h/day					24				
Sundays				]	h/day					24				
Latent heat					W/m <sup>2</sup>									
Weekdays				1	h/day									
Saturdays				1	h/day									
Sundays				1	h/day									
Part 4: Holida	i <u>ys</u>													
	Jan	Feb	Mar	Apr	May		Jun	Jul	Aug	Sep	Oct	Nov	Dec	
No. of holidays (excluding weekends)	-	-	-	-	-		-	-	-	-	-	-	-	

Part 5: Heating m	<u>ıode</u>								
	Set-p temper	oint atur	e	Duration					
Weekdays	°C	2	4	h/day			24		
Saturdays	°C	2	4		h/day		24		
Sundays	°C	2	4		h/day		24		
Unoccupied period	°C								
Holidays	°C								
Part 6: Heating s	<u>ystem</u>								
Emission efficiency					%				
Distribution efficiency					%				
Automatic control					%				
Generation efficiency					%	82			
Energy source (fue			-		Natural gas				
Fans/pumps room units					W/m <sup>2</sup>				
Pumps heating system					W/m <sup>2</sup>				
Pumps pre-heating	ventilation				W/m <sup>2</sup>	1			
Part 7: Mechanic	al ventilati	on sy	ystem (	<u>heati</u>	ng mode)	<u></u>			
	1	Su temp	pply eratur	e	Duration				
Weekdays	0	С	24		h/d	ay	24		
Saturdays	0	С	24		h/d	ay	24		
Sundays	0	С	24		h/d	ay	24		
Ventilation rate, oc	cupancy per	riod, r	n <sup>3</sup> /hm <sup>2</sup>		20				
Ventilation rate, no	on-occupanc	y, m³/	/hm²						
Heat recovery effic	viency, %						75		
Emission efficiency	y, %								
Distribution efficie	ncy, %								
Automatic control, %									
Generation efficien	всу, %								
Energy source (fue	l, energy cai	rier)				e	lectricity		
Fans, occupancy pe	eriod, W/m <sup>2</sup>								
Fans, non-occupan	cy period, W	//m²							

Part 8: Domestic ho	ot water sy	<u>stems</u>					
Quantity				l/m²year		92,57	
Temperature difference	ce			°C			
Distribution efficiency			%				
Automatic control %				%			
Generation efficiency	%			%	% 82		
Energy source (fuel, e	energy carri	er)		_ Natural gas/water			
Pumps, DHW system				W/m <sup>2</sup>			
Part 9: Cooling mod	de						
	oint ature			Dı	iration		
Weekdays	°C	21		h/day		24	
Saturdays	°C	21		h/day		24	
Sundays	°C	21		h/day		24	
Unoccupied period	°C						
Holidays	°C						
Part 10: Cooling sys	<u>stem</u>						
Emission efficiency				%			
Distribution efficiency	у			%			
Automatic control				%			
Generation efficiency				%		2,27 (EER)	
Fans/pumps room uni	ts			W/m <sup>2</sup>			
Pumps cooling system	1			W/m <sup>2</sup>			
Part 11: Mechanica	l ventilati	on system	<u>(coo</u>	ling mode)			
	Supply temper	ature				Duration	
Weekdays	°C	21			h/day	24	
Saturdays	°C	21			h/day	24	
Sundays	°C	21			h/day	24	
Ventilation rate, occu	pancy peric	od, m <sup>3</sup> /hm <sup>2</sup>				20	
Ventilation rate, non-	occupancy,	m <sup>3</sup> /hm <sup>2</sup>	[				
Heat recovery efficier	ncy, %			75			
Night - cooling, m <sup>3</sup> /h	m <sup>2</sup>						
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>				2,67			

Emission efficiency,%			
Distribution efficiency, %			
Automatic control, %			
Generation efficiency, %			
Fans, occupancy period, W	//m <sup>2</sup>		
Fans, non-occupancy perio	od, W/m <sup>2</sup>		
Fans, night cooling, W/m <sup>2</sup>			
Fans, free-cooling, W/m <sup>2</sup>			
Part 12: Appliances not	influencing the ther	mal balance	
	Average simultaneous power		Duration
Weekdays	8,04W/m <sup>2</sup>	h/day	24
Saturdays	W/m <sup>2</sup>	h/day	24
Sundays	W/m <sup>2</sup>	h/day	24

# THE FORMER YOUGOSLAV REPUBLIC OF MACEDONIA

## I. Building category: Offices / Public administration

#### Subcategory: Student housing

- The reference building should have built-up area between 100 and 1000 m2,
- Construction materials concrete +masonry; thermal properties of the building envelope
- Occupancy schedule 8 h/day 5 days/week,
- Technical systems: central heating with two options:
  - a) based on light oil burning water heating boiler
  - b) based on district heating

#### Table MK1: Template for reporting the reference building input data

Building category		Offices / Public administration				
Sub-category		Regional Local Authorities				
Conditioned area	m2	167				
Conditioned volume	m <sup>3</sup>	384				
Climatic zone		Ref. number: 2 City: Skopje				
Part 1: Building (Zone) geometry						
Walls, north	m <sup>2</sup>	50				
Walls, east	m <sup>2</sup>	4,80				
Walls, south	m <sup>2</sup>	50				

Walls, west	m <sup>2</sup>	20,65				
Windows, north	m <sup>2</sup>	3	32,90			
Windows, east	m <sup>2</sup>		1,90			
Windows, south	m <sup>2</sup>	2	28,20			
Windows, west	m <sup>2</sup>	12,40				
Roof	m <sup>2</sup>	167				
Floor	m <sup>2</sup>	167				
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,61	Requirement at 2014 0,35			
ΔUtb	W/m <sup>2</sup> K		/			
b(ground)	-		/			
b(un-conditioned space)	-		/			
b(adjacent sunspace)	-		/			
b(adjacent building)	m <sup>2</sup>		/			
Uwindows	W/m <sup>2</sup> K	Prior to investment 3,3	Requirement at 2014 1,3-2			
fraction of the window frame area	%	20%				
g(F)	-	/				
Uroof	W/m <sup>2</sup> K	Prior to investment 2,84	Requirement at 2014 0,25			
Ufloor	W/m <sup>2</sup> K	Prior to investment 0,76	Requirement at 2014 0,4			
3	-	(	),95			
α	-		/			
Infiltration, occupancy period	$\mathbf{h}^{-1}$		0,5			
Infiltration, non occupancy	$\mathbf{h}^{-1}$		0,5			
Thermal capacity	Wh/m <sup>2</sup> K		69			
Part 3: Internal gains and operation	nal schedule					
Metabolic heat (occupants)	W/m <sup>2</sup>		8,38			
Latent metabolic heat	W/m <sup>2</sup>		/			
Weekdays	h/day		8			
Saturdays	h/day		0			
Sundays	h/day		0			
Lighting for illumination	W/m <sup>2</sup>		1,5			
Weekdays	h/day		5			
Saturdays	h/day		0			

Sundays			]	h/day			0							
Lighting, emer	gency/	controls			W/m <sup>2</sup>			/						
Weekdays					h/day			/						
Saturdays					h/day			/						
Sundays					h/day					/				
Appliances				ſ	W/m <sup>2</sup>					45	i			
Weekdays				]	h/day		6							
Saturdays				]	h/day					0				
Sundays				]	h/day					0				
Latent heat					W/m <sup>2</sup>					/				
Weekdays				]	h/day					/				
Saturdays				]	h/day					/				
Sundays				]	h/day					/				
Part 4: Holida	<u>iys</u>													
	Jan	Feb	Mar	Apr	May	Jui	n	Jul	Aug	Sep	Oct	Nov	Dec	
No. of holidays (excluding weekends)	4	0	0	2	3	0		1	2	1	2	0	1	
Part 5: Heat	ting m	ode				<u>n</u>	<u> </u>				<u> </u>	<u> </u>		
		Set-p temper	oint ature		Duration									
Weekdays		°C	20		h/da	y		8						
Saturdays		°C	0		h/da	y		0						
Sundays		°C	0		h/da	y		0						
Unoccupied period		°C	0					0						
Holidays		°C	0					0						
Part 6: Heatin	ig syst	t <u>em</u>												
Emission efficiency				%			100							
Distribution efficiency				%			95							
Automatic cont	trol				%		100							
Generation effi	ciency				%		100							
Energy source	(fuel, e	energy ca	arrier)		_			Electricity						
Fans/pumps roo	om uni	ts			W/n	n <sup>2</sup>	/							
Pumps heating	systen	1			W/m <sup>2</sup>			0,41						

Pumps pre-heating ventilation			W/m <sup>2</sup>		/
Part 7: Mechanica	al ventilation system	n (heat	ting mode) <u>N/A</u>		
	Supply temperat	ure		tion	
Weekdays	°C		h/day	h/d	ay with full ventilation rate (occupancy period)
Saturdays	°C		h/day		
Sundays	°C		h/day		
Ventilation rate, occ	cupancy period, m <sup>3</sup> /h	m <sup>2</sup>			
Ventilation rate, not	n-occupancy, m <sup>3</sup> /hm <sup>2</sup>				
Heat recovery efficient	iency, %				
Emission efficiency	<i>r</i> , %				
Distribution efficien	ncy, %				
Automatic control,	%				
Generation efficient	су, %				
Energy source (fuel	, energy carrier)				
Fans, occupancy pe	eriod, W/m <sup>2</sup>				
Fans, non-occupanc	cy period, W/m <sup>2</sup>				
Part 8: Domestic I	hot water systems <u>N</u>	<u>//A</u>			
Quantity			l/m²year		
Temperature differe	ence		°C		
Distribution efficier	ncy		%		
Automatic control 9	%		%		
Generation efficient	cy %		%		
Energy source (fuel	, energy carrier)		-		
Pumps, DHW syste	m		W/m <sup>2</sup>		
Part 9: Cooling m	ode <u>N/A</u>				
	Set-point temperature			Duratio	n
Weekdays	°C		h/day	h/day wit	th set-point temperature
Saturdays	°C		h/day		
Sundays	°C		h/day		
Unoccupied period	°C				
Holidays	°C				

Part 10: Cooling syste	<u>em N/A</u>				
Emission efficiency			%		
Distribution efficiency			%		
Automatic control			%		
Generation efficiency			%		
Fans/pumps room units			W/m <sup>2</sup>		
Pumps cooling system			W/m <sup>2</sup>		
Part 11: Mechanical	ventilation system	em (co	oling mode)	N/A	
	Supply temperature				Duration
Weekdays	°C		h/day		h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/da	ý	
Sundays	°C		h/day	ý	
Ventilation rate, occupancy period, m <sup>3</sup> /hm <sup>2</sup>		m <sup>2</sup>			
Ventilation rate, non-oc	cupancy, m <sup>3</sup> /hm <sup>2</sup>	2			
Heat recovery efficiency	y, %				
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>	2				
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>					
Emission efficiency,%					
Distribution efficiency,	%				
Automatic control, %					
Generation efficiency, 9	6				
Fans, occupancy period	, W/m²				
Fans, non-occupancy pe	eriod, W/m <sup>2</sup>				
Fans, night cooling, W/	m <sup>2</sup>				
Fans, free-cooling, W/m	1 <sup>2</sup>				
Part 12: Appliances n	ot influencing	the the	ermal balance	<u>e N/A</u>	
	Average simultaneous	e power			Duration
Weekdays	W/m <sup>2</sup>		h/d	ay	
Saturdays	W/m <sup>2</sup>		h/d	ay	
Sundays	W/m <sup>2</sup>		h/d	ay	

## II. Building category: Educational buildings

#### **Subcategory: Schools**

- The reference building should have built-up area between 1000 and 5000 m2,
- Construction materials concrete +masonry; thermal properties of the building envelope
- Occupancy schedule 16 h/day 5 days/week,
- $\circ$   $\;$  Technical systems: central heating with two options:
  - a) based on light oil burning water heating boiler
  - b) based on district heating

## Table MK2: Template for reporting the reference building input data

Building category		Education	nal buildings				
Sub-category		Sc	hools				
Conditioned area	m2	3822					
Conditioned volume	m <sup>3</sup>	14466					
Climatic zone	1	Ref. number: 2 C	City: Skopje				
Part 1: Building (Zone) geometry							
Walls, north	m <sup>2</sup>		436				
Walls, east	m <sup>2</sup>		304				
Walls, south	m <sup>2</sup>		459				
Walls, west	m <sup>2</sup>		267				
Windows, north	m <sup>2</sup>	271					
Windows, east	m <sup>2</sup>	80,2					
Windows, south	m <sup>2</sup>	356					
Windows, west	m <sup>2</sup>	123,4					
Roof	m <sup>2</sup>	1	400				
Floor	m <sup>2</sup>	1	400				
Part 2: Building (Zone) properties							
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,52	Requirement at 2014 0,35				
ΔUtb	W/m <sup>2</sup> K		/				
b(ground)	-		/				
b(un-conditioned space)	-	/					
b(adjacent sunspace)	-		/				
b(adjacent building)	$m^2$		/				
Uwindows	W/m <sup>2</sup> K	Prior to investment 2,85	Requirement at 2014 1,3-2				

fraction of the	window	frame a	rea	(	%	20%							
g(F)					-				/	/			
Uroof				W/	m <sup>2</sup> K	Prior	to inve 0,6	stment 4	Re	quireme	ent at 20 0,25	14	
Ufloor				W/	m <sup>2</sup> K	Prior	to inve 2,6	stment 2	Re	quireme	ent at 20 0,4	14	
3					-				0,95				
α					-				/				
Infiltration, occ	upancy	period		ł	n <sup>-1</sup>				0,5				
Infiltration, nor	n occupa	uncy		ł	n <sup>-1</sup>				0,5				
Thermal capaci	ty			Wh	$/m^2K$				72				
<u>Part 3: Intern</u>	al gain:	s and o	peration	nal sch	edule								
Metabolic heat	(occup	ants)		V	W/m <sup>2</sup>	6,13							
Latent metabol	ic heat			V	W/m <sup>2</sup>				/				
Weekdays				h	/day				9				
Saturdays				h	/day				0				
Sundays			h	/day				0					
Lighting for illumination			V	W/m <sup>2</sup>	1,4								
Weekdays				h	/day		5						
Saturdays	Saturdays			h	/day				0				
Sundays	Sundays				/day				0				
Lighting, emer	gency/c	ontrols		V	V/m <sup>2</sup>				/				
Weekdays				h	/day				/				
Saturdays				h	/day				/				
Sundays				h	/day				/				
Appliances				V	V/m <sup>2</sup>				2				
Weekdays				h	/day				3				
Saturdays				h	/day				0				
Sundays				h	/day	0							
Latent heat				V	W/m <sup>2</sup>		/						
Weekdays				h	/day				/				
Saturdays				h	/day				/				
Sundays				h	/day				/				
Part 4: Holida	iys												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
No. of	15	0	0	2	2	10	23	22	2	2	1	1	
holidays (excluding weekends)													
--------------------------------------	-----------------------	--------------------------	------------------------	------------------	--------------------	-----------------------	-----------	---------	----------------	----------------------	------------------------	---------	
Part 5: Heating mode													
	s ter	Set-point temperature			Duration								
Weekdays	°C		20		h/day			16					
Saturdays	°C		14		h/da	ıy		16					
Sundays	°C	1	14		h/da	ıy				16			
Unoccupied period	°C		14					16					
Holidays	°C		14							16			
Part 6: Heating system													
Emission efficient	су				%				1	00			
Distribution effici	iency				%				ç	95			
Automatic control	1				%				N/A				
Generation efficiency			%				100						
Energy source (fuel, energy carrier)			-				District	Heating	3				
Fans/pumps room	Fans/pumps room units			W/m <sup>2</sup>	W/m <sup>2</sup> /								
Pumps heating sy	stem				W/m <sup>2</sup>	W/m <sup>2</sup> 0,56							
Pumps pre-heating	g ventila	tion			W/m <sup>2</sup>	W/m <sup>2</sup> /							
<u>Part 7: Mechani</u>	ical ven	tilati	on syst	em (he	ating m	<u>ode)</u> <u>N</u>	<u>/A</u>						
		te	Supp empera	oly ature		Duration							
Weekdays		°	C			h/da	ау	h	/day wi (oc	th full v cupancy	entilatio v period)	on rate	
Saturdays		° <b>(</b>	С			h/da	ay						
Sundays		°(	C			h/da	ay						
Ventilation rate, o	occupanc	ey per	riod, m <sup>3</sup> /	/hm²									
Ventilation rate, n	ion-occu	ipancy	y, m³/hr	n²									
Heat recovery efficiency, %													
Emission efficiency, %													
Distribution efficiency, %													
Automatic control	1, %												
Generation efficie	ency, %												
Energy source (fuel, energy carrier)													

Fans, occupancy period, W/m <sup>2</sup>					
Fans, non-occupancy	2				
Part 8: Domestic h	ot water syste	ems <u>N/A</u>			
Quantity			l/m²year		
Temperature differen	nce		°C		
Distribution efficient	су		%		
Automatic control %			%		
Generation efficienc	у %		%		
Energy source (fuel,	energy carrier	)	-		
Pumps, DHW system	n		W/m <sup>2</sup>		
Part 9: Cooling mo	ode <u>N/A</u>				
	Set-poin temperat	nt ure		I	Duration
Weekdays	°C		h/day	]	h/day with set-point temperature
Saturdays	°C		h/day		
Sundays	°C		h/day		
Unoccupied period	°C				
Holidays	°C				
Part 10: Cooling sy	vstem <u>N/A</u>				
Emission efficiency			%		
Distribution efficient	су		%		
Automatic control			%		
Generation efficienc	у		%		
Fans/pumps room un	nits		W/m <sup>2</sup>		
Pumps cooling syste	m		W/m <sup>2</sup>		
Part 11: Mechanic	al ventilation	a system (co	ooling mode) <u>N</u>	<u>//A</u>	
	Supply temperatu	re			Duration
Weekdays	°C		h/day		h/day with full ventilation rate (occupancy period)
Saturdays	°C		h/day		
Sundays	°C		h/day		
Ventilation rate, occ	upancy period,	, m <sup>3</sup> /hm <sup>2</sup>			

Ventilation rate, non-occu	pancy, m <sup>3</sup> /hm <sup>2</sup>		
Heat recovery efficiency,	%		
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>			
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>			
Emission efficiency,%			
Distribution efficiency, %			
Automatic control, %			
Generation efficiency, %			
Fans, occupancy period, W	V/m <sup>2</sup>		
Fans, non-occupancy period	od, W/m <sup>2</sup>		
Fans, night cooling, W/m <sup>2</sup>			
Fans, free-cooling, W/m <sup>2</sup>			
Part 12: Appliances not	influencing the the	rmal balance <u>N/A</u>	
	Average simultaneous power		Duration
Weekdays	W/m <sup>2</sup>	h/day	
Saturdays	W/m <sup>2</sup>	h/day	

#### III. Building category: Educational buildings

#### **Subcategory: Kindergartens**

Sundays

- The reference building should have built-up area between 500 and 3000 m2,
- Construction materials concrete +masonry; thermal properties of the building envelope

h/day

- Occupancy schedule 16 h/day 5-7 days/week,
- Technical systems: central heating with two options:

W/m<sup>2</sup>

- a) based on light oil burning water heating boiler
- b) based on district heating

#### Table MK3: Template for reporting the reference building input data

Building category		Educational buildings
Sub-category		Kindergartens
Conditioned area	m2	625
Conditioned volume	m <sup>3</sup>	3072
Climatic zone		Ref. number: 1 City: Pehcevo
Part 1: Building (Zone) geometry		
Walls, north	m <sup>2</sup>	79

Walls, east	m <sup>2</sup>		107	
Walls, south	m <sup>2</sup>		40	
Walls, west	m <sup>2</sup>		92	
Windows, north	m <sup>2</sup>		57.8	
Windows, east	m <sup>2</sup>		4	
Windows, south	m <sup>2</sup>		113,3	
Windows, west	m <sup>2</sup>		10	
Roof	m <sup>2</sup>		818	
Floor	m <sup>2</sup>		625	
Part 2: Building (Zone) properties	5			
Uwalls	W/m <sup>2</sup> K	Prior to investment 1,67	Requirement at 2014 0,35	
ΔUtb	W/m <sup>2</sup> K		/	
b(ground)	-		/	
b(un-conditioned space)	-		/	
b(adjacent sunspace)	-	/		
b(adjacent building)	m <sup>2</sup>		/	
Uwindows	W/m <sup>2</sup> K	Prior to investment 3,8	Requirement at 2014 1,3-2	
fraction of the window frame area	%		20%	
g(F)	-		/	
Uroof	W/m <sup>2</sup> K	Prior to investment 1,59	Requirement at 2014 0,25	
Ufloor	W/m <sup>2</sup> K	Prior to investment 0,76	Requirement at 2014 0,4	
3	-		0,95	
α	-		/	
Infiltration, occupancy period	h <sup>-1</sup>		0,5	
Infiltration, non occupancy	h <sup>-1</sup>		0,5	
Thermal capacity	Wh/m <sup>2</sup> K		60	
Part 3: Internal gains and operati	onal schedule			
Metabolic heat (occupants)	W/m <sup>2</sup>		12,09	
Latent metabolic heat	W/m <sup>2</sup>		/	
Weekdays	h/day		10	
Saturdays	h/day		0	
Sundays	h/day		0	
Lighting for illumination	W/m <sup>2</sup>		9,1	

Weekdays	h/day	4
Saturdays	h/day	0
Sundays	h/day	0
Lighting, emergency/controls	W/m <sup>2</sup>	/
Weekdays	h/day	/
Saturdays	h/day	/
Sundays	h/day	/
Appliances	W/m <sup>2</sup>	83,87
Weekdays	h/day	4
Saturdays	h/day	0
Sundays	h/day	0
Latent heat	W/m <sup>2</sup>	/
Weekdays	h/day	/
Saturdays	h/day	/
Sundays	h/day	/
Dant A. Halidana		

#### Part 4: Holidays

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
No. of holidays (excluding weekends)	4	0	0	2	3	0	1	2	1	2	0	1

# Part 5: Heating mode

	Set-p temper	oint cature	Duration		
Weekdays	°C	21	h/day	10	
Saturdays	°C	0	h/day	0	
Sundays	°C	0	h/day	0	
Unoccupied period	°C	0		0	
Holidays	°C	0		0	
Part 6: Heating	<u>system</u>				
Emission efficience	су		%	100	
Distribution efficient	ency		%	95	
Automatic control		%	N/A		
Generation efficiency		%	70		
Energy source (fue	el, energy ca	arrier)	-	District Heating	

Fans/pumps room uni	ts		W/m <sup>2</sup>		/		
Pumps heating system	1		W/m <sup>2</sup>		0,74		
Pumps pre-heating ve	Pumps pre-heating ventilation			W/m <sup>2</sup> /			
Part 7: Mechanical	ventilation sy	stem (hea	ting mode) N/	<u>'A</u>			
	Suj tempe	pply erature		Duration			
Weekdays	°C		h/da	ıy	h/day with full ventilation rate (occupancy period)		
Saturdays	°C		h/da	ıy			
Sundays	°C		h/da	ıy			
Ventilation rate, occu	pancy period, r	n³/hm²					
Ventilation rate, non-	occupancy, m <sup>3</sup> /	hm²					
Heat recovery efficient	ncy, %						
Emission efficiency,	%						
Distribution efficiency	y, %						
Automatic control, %							
Generation efficiency	, %						
Energy source (fuel, e	energy carrier)						
Fans, occupancy period	od, W/m²						
Fans, non-occupancy	period, W/m <sup>2</sup>						
Part 8: Domestic ho	ot water system	ns <u>N/A</u>					
Quantity			l/m²year				
Temperature difference	се		°C				
Distribution efficiency	у		%				
Automatic control %			%				
Generation efficiency	%		%				
Energy source (fuel, e	energy carrier)		-				
Pumps, DHW system			W/m <sup>2</sup>				
Part 9: Cooling mod	<u>de N/A</u>						
	Set-point temperatu	re		Du	ration		
Weekdays	°C		h/day	h/da	ay with set-point temperature		
Saturdays	°C		h/day				
Sundays	°C		h/day				
Unoccupied period	°C						

Holidays	°C					
Part 10: Cooling sys	stem <u>N/A</u>					
Emission efficiency				%		
Distribution efficiency	у			%		
Automatic control				%		
Generation efficiency				%		
Fans/pumps room uni	ts			W/m <sup>2</sup>		
Pumps cooling system	ı			W/m <sup>2</sup>		
Part 11: Mechanica	l ventilat	ion system	(co	<u>oling mode) N</u>	<u>//A</u>	
	Supply temper	ature				Duration
Weekdays	°C			h/day		h/day with full ventilation rate (occupancy period)
Saturdays	°C			h/day		
Sundays	°C			h/day		
Ventilation rate, occup	pancy peri	od, m <sup>3</sup> /hm <sup>2</sup>				
Ventilation rate, non-	occupancy	, m <sup>3</sup> /hm <sup>2</sup>				
Heat recovery efficier	ncy, %					
Night - cooling, m <sup>3</sup> /h	m <sup>2</sup>					
Free – cooling, m <sup>3</sup> /hm	1 <sup>2</sup>					
Emission efficiency,%	ó					
Distribution efficiency	y, %					
Automatic control, %						
Generation efficiency	, %					
Fans, occupancy period	od, W/m <sup>2</sup>					
Fans, non-occupancy	period, W	/m <sup>2</sup>				
Fans, night cooling, V	V/m <sup>2</sup>					
Fans, free-cooling, W	/m <sup>2</sup>					
Part 12: Appliances	<u>not influ</u>	encing the	e the	e <mark>rmal balance</mark>	<u>N/A</u>	
Average simultaneous power			ower	r		Duration
Weekdays		W/m <sup>2</sup>		h/da	ny	
Saturdays		W/m <sup>2</sup>		h/da	ny	
Sundays		W/m <sup>2</sup>		h/da	ıy	

## UNITED KINGDOM

## I. Building category: Office/Administrative buildings

## Subcategory: Office

#### Table UK1:Office/administrative buildings

Building category		Off	ïce				
Subcategory		Victorian C	office Block				
Conditioned area	m <sup>2</sup>	1314					
Conditioned volume	m <sup>3</sup>	39	3986				
Climatic zone		Ref. number: WC08L0 TRY/DSY Hourly Weat City: London	ON - Current CIBSE ther Data Set - London				
Part 1: Building (Zone) geometry							
Walls, north	$m^2$	25	8				
Walls, east	m <sup>2</sup>	24	5				
Walls, south	m <sup>2</sup>	20	4				
Walls, west	m <sup>2</sup>	224					
Windows, north	m <sup>2</sup>	40					
Windows, east	m <sup>2</sup>	54					
Windows, south	m <sup>2</sup>	66					
Windows, west	m <sup>2</sup>	41					
Roof	m <sup>2</sup>	485					
Floor	m <sup>2</sup>	536					
Part 2: Building (Zone) properties	<u>s</u>						
Uwalls	W/m <sup>2</sup> K	Prior to investment 2,10	Requirement at 2014 0,30 <sup>1</sup>				
ΔUtb	W/m <sup>2</sup> K	Calculation based on psi-values					
b(ground)	-	Included in U-values					
b(un-conditioned space) -		Included in U-values					
b(adjacent sunspace) -		Included in U-values					
b(adjacent building)	m <sup>2</sup>	Included in U-values					
Uwindows W/m <sup>2</sup> K		Prior to investment 4,9 Requirement at 2014 1,8					
fraction of the window frame area	%	1	10 <sup>2</sup>				

<sup>&</sup>lt;sup>1</sup> Approved Document L2B

g(F)	-	0	,85		
Uroof	W/m <sup>2</sup> K	Prior to investment 2,5	Requirement at 2014 0,18		
Ufloor	W/m <sup>2</sup> K	Prior to investment 1,0	Requirement at 2014 0,25		
ε	-	0,93 <sup>3</sup>			
α	-	0	,65		
Infiltration, occupancy period	$h^{-1}$		1,5		
Infiltration, non occupancy	$h^{-1}$		1,5		
Thermal capacity	Wh/m <sup>2</sup> K		38 <sup>4</sup>		
Part 3: Internal gains and operation	onal schedule				
Sensible Metabolic heat (occupants)	W/m <sup>2</sup>	120*nb occupants /	area = 120/18 = 6.7		
Latent metabolic heat	W/m <sup>2</sup>	n/a			
Weekdays	h/day	10			
Saturdays	h/day	0			
Sundays	h/day	0			
Lighting for illumination	W/m <sup>2</sup>	15 <sup>5</sup>			
Weekdays	h/day	12			
Saturdays	h/day		0		
Sundays	h/day		0		
Lighting, emergency/controls	W/m <sup>2</sup>	Can be neglected compare illumination	d to lighting for		
Weekdays	h/day				
Saturdays	h/day				
Sundays	h/day				
Appliances	W/m <sup>2</sup>	1	5		
Weekdays	h/day	12			
Saturdays	h/day	0			
Sundays	h/day	0			
Latent heat	W/m <sup>2</sup>	For cooling calculations			

<sup>2</sup> Default value from NCM modelling guide for buildings other than dwellings in England

<sup>3</sup> Values for typical brick wall, http://www.solarmirror.com/fom/fom-serve/cache/43.html

<sup>4</sup> 600mm brick wall

 $\frac{https://books.google.co.uk/books?id=YichPartackC&pg=PA89&lpg=PA89&dq=internal+gains+w/m2+lightings+in+office&source=bl&ots=mssC4Bx30D&sig=FMI8KJI7JdUA50wJhwEX0dacMWE&hl=fr&sa=X&ei=Ria-VKK9Joqp7AbS1YHgCQ&ved=0CDoQ6AEwAw#v=onepage&q=internal%20gains%20w%2Fm2%20lightings%20in%20office&f=false$ 

Weekdays					h/day	/day								
Saturdays				]	h/day	7								
Sundays				]	h/day	7								
Part 4: Holiday	<u>vs</u>		<u> </u>			<u> </u>								
	Jan	Feb	Mar	Α	pr	pr May Jun Jul Aug Sep Oct No						Nov	Dec	
No. of holidays (excluding weekends)	3	0	0		2	2 0			2	0	0	0	5	
Part 5: Heating mode														
		Set- tempe	point erature	<b>;</b>					Durati	on				
Weekdays		°C	22Err ookm no defin	ror! ark t ed.	h/day x						13			
Saturdays		°C	12			h/da	ıy				13			
Sundays		°C	12			h/da	ıy		13					
Unoccupied period		°C	12	,										
Holidays		°C	12											
Part 6: Heating	<u>syster</u>	<u>m</u>												
Emission efficies	ncy			Τ		%	?							
Distribution efficient	ciency <sup>6</sup>					%		90						
Automatic control	ol					%				n/a	l			
Generation efficient	iency					%				84				
Energy source (f	fuel, en	ergy cai	rier)			-				Natura	l gas			
Fans/pumps room	m units				V	W/m <sup>2</sup>				?				
Pumps heating s	ystem				V	W/m <sup>2</sup>				?				
Pumps pre-heating	ng vent	ilation			V	W/m <sup>2</sup>				?				
Part 7: Mechar	<u>iical v</u>	entilati	on syst	<u>em ()</u>	heati	ng moa	<u>le)</u>							
		ter	Supply nperat	y cure			Duration							
Weekdays		°C					h/day				n/a			
Saturdays		°C					h/day				n/a			

<sup>6</sup> Taken to be Seasonal Coefficient of Performance (SCoP)

Sundays	°C		h/day	7	n/a			
Ventilation rate, occup	ancy period	, m <sup>3</sup> /hm <sup>2</sup>			n/a			
Ventilation rate, non-o	ccupancy, m	1 <sup>3</sup> /hm <sup>2</sup>		n/a				
Heat recovery efficient	су, %		n/a					
Emission efficiency, %	)				n/a			
Distribution efficiency,				n/a				
Automatic control, %				n/a				
Generation efficiency,	%				n/a			
Energy source (fuel, en	nergy carrier	)			n/a			
Fans, occupancy period	d, W/m²				n/a			
Fans, non-occupancy p	eriod, W/m <sup>2</sup>	2			n/a			
Part 8: Domestic hot water systems								
Quantity			l/m²year		400 <sup>7</sup>			
Temperature difference	e		°C		36.7 <sup>8</sup>			
Distribution efficiency		%		95				
Automatic control %		%		?				
Generation efficiency 9	%		%		73			
Energy source (fuel, er	nergy carrier	)	-		Natural gas			
Pumps, DHW system			W/m <sup>2</sup>	Unknown				
Part 9: Cooling mode	<u>e</u>							
	Set-po	int		1	Duration			
	tempera	iture						
Weekdays	°C		h/day		n/a			
Saturdays	°C		h/day		n/a			
Sundays	°C		h/day		n/a			
Unoccupied period	°C				n/a			
Holidays	°C				n/a			
Part 10: Cooling syst	t <u>em</u>							
Emission efficiency			%		n/a			
Distribution efficiency			%		n/a			
Automatic control			%		n/a			
Generation efficiency			%		n/a			
Fans/pumps room units	8		W/m <sup>2</sup>		n/a			

 <sup>&</sup>lt;sup>7</sup> <u>http://ec.europa.eu/environment/water/quantity/pdf/Water%20Performance%20of%20Buildings\_Study2009.pdf</u>
 <sup>8</sup> Measurement oh domestic hot water consumption in dwellings, energy saving trust

Pumps cooling system	umps cooling system			W/m <sup>2</sup> n/a					
Part 11: Mechanical ve	entilation system	(cooling mode)	•						
	Supply								
	temperature		Duration						
Weekdays	°C	h/da	y	n/a					
Saturdays	°C	h/da	h/day n/a						
Sundays	°C	h/da	ý	n/a					
Ventilation rate, occupan	cy period, m <sup>3</sup> /hm <sup>2</sup>		n/a						
Ventilation rate, non-occ	upancy, m <sup>3</sup> /hm <sup>2</sup>		n/a						
Heat recovery efficiency,	%			n/a					
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>				n/a					
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>				n/a					
Emission efficiency,%				n/a					
Distribution efficiency, %	, )		n/a						
Automatic control, %				n/a					
Generation efficiency, %				n/a					
Fans, occupancy period,	W/m <sup>2</sup>		n/a						
Fans, non-occupancy per	iod, W/m <sup>2</sup>		n/a						
Fans, night cooling, W/m	2			n/a					
Fans, free-cooling, W/m <sup>2</sup>				n/a					
Part 12: Appliances no	t influencing the	thermal balance							
	Average simultaneous p	oower		Duration					
Weekdays	W/m <sup>2</sup>	h/c	lay						
Saturdays	W/m <sup>2</sup>	h/c	lay						
Sundays	W/m <sup>2</sup>	h/c	lay						

#### II. Category: Educational buildings

#### Subcategory: Schools

#### Table UK2: Educational buildings, School

Building category		School					
Subcategory		Secondary school					
Conditioned area	m <sup>2</sup>	11 156					
Conditioned volume	m <sup>3</sup>	42 416					
Climatic zone		Ref. number: WC08LON - Current CIBSE					

		TRY/DSY Hourly Weather Data Set - London City: London				
Part 1: Building (Zone) geometry						
Walls, north	m <sup>2</sup>	11	24			
Walls, east	m <sup>2</sup>	721				
Walls, south	m <sup>2</sup>	12	02			
Walls, west	m <sup>2</sup>	54	15			
Windows, north	$m^2$	44	19			
Windows, east	$m^2$	9	9			
Windows, south	$m^2$	45	59			
Windows, west	m <sup>2</sup>	17	17			
Roof	m <sup>2</sup>	53	43			
Floor	m <sup>2</sup>	53	43			
Part 2: Building (Zone) properties						
Uwalls	W/m <sup>2</sup> K	Prior to investment 0,45	Requirement at 2014 0,30 <sup>9</sup>			
ΔUtb	W/m <sup>2</sup> K	Calculation based on psi-values				
b(ground)	-	Included in U-values				
b(un-conditioned space)	-	Included in U-values				
b(adjacent sunspace)	-	Included in U-values				
b(adjacent building)	m <sup>2</sup>	Included in U-values				
Uwindows	W/m <sup>2</sup> K	Prior to investment 3,3	Requirement at 2014 1,8			
fraction of the window frame area	%	10	0 <sup>10</sup>			
g(F)	-	0	,7			
Uroof	W/m <sup>2</sup> K	Prior to investment 0,5	Requirement at 2014 0,18			
Ufloor	W/m <sup>2</sup> K	Prior to investment 0,45	Requirement at 2014 0,25			
3	-	0,9	9311			
α	-	0,	65			
Infiltration, occupancy period	h <sup>-1</sup>		1			
Infiltration, non occupancy	h <sup>-1</sup>		1			

<sup>&</sup>lt;sup>9</sup> Approved Document L2B

<sup>&</sup>lt;sup>10</sup> Default value from NCM modelling guide for buildings other than dwellings in England <sup>11</sup> Values for typical brick wall, http://www.solarmirror.com/fom/fom-serve/cache/43.html

Thermal capacity	y				Wh	$/m^2K$		38 <sup>12</sup>							
Part 3: Interna	l ga	ins	and op	peration	al sch	edule									
Sensible Metabo	olic i	heat	t (occup	ants)		W/m <sup>2</sup>				72 <sup>13</sup> *9	978 <sup>14</sup> /11	,156=6.	3		
Latent metabolic	c he	at				W/m <sup>2</sup>					n/a				
Weekdays						h/day		8							
Saturdays						h/day		0							
Sundays						h/day					0				
Lighting for illumination						W/m²					10				
Weekdays						h/day					14				
Saturdays						h/day					0				
Sundays						h/day					0				
Lighting, emergency/controls					W/m <sup>2</sup>		Can illu	n be neg minatio	lected c n	ompare	d to ligh	ting for			
Weekdays					h/day					n/a					
Saturdays						h/day		n/a							
Sundays						h/day					n/a				
Appliances						W/m²					5				
Weekdays						h/day					14				
Saturdays						h/day					0				
Sundays						h/day		0							
Latent heat						W/m <sup>2</sup>		n/a							
Weekdays						h/day		n/a							
Saturdays						h/day		n/a							
Sundays						h/day					n/a				
Part 4: Holiday	<u>'S</u>														
	Ja	n	Feb	Mar	Apr	May	J	un	Jul	Aug	Sep	Oct	Nov	Dec	
No. of holidays (excluding weekends)	2	2	5	2	10	5		0	15	20	0	5	0	9	
Part 5: Heating	g ma	ode													
Set-point temperature					Duration										

 <sup>&</sup>lt;sup>12</sup> 600mm brick wall
 <sup>13</sup> <u>https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/3059/3/EIS%2325%20Havenith%207June07%20FINAL.pdf</u>
 <sup>14</sup> National average from government

Weekdays	°C	18 <sup>15</sup>		h/day		12				
Saturdays	°C	18		h/day		12				
Sundays	°C	18		h/day		12				
Unoccupied period	°C	12								
Holidays	°C	12								
Part 6: Heating sy	vstem_									
Emission efficiency	1			%		?				
Distribution efficiency <sup>16</sup>				%		90				
Automatic control				%		n/a				
Generation efficien	cy			%		61				
Energy source (fuel	, energy car	rrier)		-		Natural gas				
Fans/pumps room u	inits			W/m <sup>2</sup>	?					
Pumps heating syst	Pumps heating system					?				
Pumps pre-heating ventilation				W/m <sup>2</sup>		?				
Part 7: Mechanical ventilation system (heating mode)										
	t	Supply emperatu	ire		Ι	Duration				
Weekdays	t	Supply emperatu	ire	h/day	I	Duration n/a				
Weekdays Saturdays	• •	Supply emperatu C	ire	h/day h/day	I 	Duration n/a n/a				
Weekdays Saturdays Sundays		Supply emperatu C C C C	ıre	h/day h/day h/day	I 	Duration n/a n/a n/a n/a				
Weekdays Saturdays Sundays Ventilation rate, oct	t o o cupancy per	Supply emperatu C C C C riod, m³/hn	n <sup>2</sup>	h/day h/day h/day	I	Duration          n/a         n/a         n/a         n/a         n/a         n/a				
Weekdays Saturdays Sundays Ventilation rate, oct Ventilation rate, no	t o o cupancy per n-occupanc	Supply emperatu C C C c riod, m <sup>3</sup> /hm y, m <sup>3</sup> /hm <sup>2</sup>	n <sup>2</sup>	h/day h/day h/day	I	Duration          n/a         n/a         n/a         n/a         n/a         n/a         n/a         n/a				
Weekdays Saturdays Sundays Ventilation rate, oc Ventilation rate, no Heat recovery effic	t o o cupancy per n-occupanc iency, %	Supply emperatu C C C C riod, m <sup>3</sup> /hm <sup>2</sup>	n <sup>2</sup>	h/day h/day h/day	I	n/a				
Weekdays Saturdays Sundays Ventilation rate, oc Ventilation rate, no Heat recovery effic Emission efficiency	t cupancy per n-occupanc iency, %	Supply emperatu C C C C riod, m <sup>3</sup> /hn y, m <sup>3</sup> /hm <sup>2</sup>	n <sup>2</sup>	h/day h/day h/day	I	n/a				
Weekdays Saturdays Sundays Ventilation rate, oc Ventilation rate, no Heat recovery effic Emission efficiency Distribution efficiency	t or or cupancy per n-occupanc iency, % 7, %	Supply emperatu C C C C riod, m <sup>3</sup> /hm <sup>2</sup>	n <sup>2</sup>	h/day h/day h/day	I	n/a				
Weekdays Saturdays Sundays Ventilation rate, oc Ventilation rate, no Heat recovery effic Emission efficiency Distribution efficiency Automatic control,	t cupancy per n-occupanc iency, % 7, %	Supply emperatu C C C riod, m <sup>3</sup> /hm <sup>2</sup>	<b>Ire</b>	h/day h/day h/day	I 	n/a				
Weekdays Saturdays Sundays Ventilation rate, oc Ventilation rate, no Heat recovery effic Emission efficiency Distribution efficient Automatic control, Generation efficient	t cupancy per n-occupanc iency, % 7, % ncy, % % cy, %	Supply emperatu C C C C riod, m <sup>3</sup> /hm <sup>2</sup>	n <sup>2</sup>	h/day h/day h/day	I	n/a				
Weekdays Saturdays Sundays Ventilation rate, oc Ventilation rate, oc Ventilation rate, no Heat recovery effic Emission efficiency Distribution efficien Automatic control, Generation efficien Energy source (fuel	t cupancy per n-occupanc iency, % 7, % ncy, % % cy, % l, energy car	Supply emperatu C C C riod, m <sup>3</sup> /hm <sup>2</sup> y, m <sup>3</sup> /hm <sup>2</sup>	n <sup>2</sup>	h/day h/day h/day	I 	n/a				
Weekdays Saturdays Sundays Ventilation rate, oc Ventilation rate, no Heat recovery effic Emission efficiency Distribution efficien Automatic control, Generation efficien Energy source (fuel Fans, occupancy pe	t cupancy per n-occupanc iency, % 7, % ncy, % % cy, % l, energy car priod, W/m <sup>2</sup>	Supply emperatu C C C C riod, m <sup>3</sup> /hm <sup>2</sup> y, m <sup>3</sup> /hm <sup>2</sup>	n <sup>2</sup>	h/day h/day h/day	I 	n/a         n/a				
Weekdays Saturdays Sundays Ventilation rate, oc Ventilation rate, no Heat recovery effic Emission efficiency Distribution efficien Automatic control, Generation efficien Energy source (fuel Fans, occupancy pe Fans, non-occupance	t cupancy per n-occupanc iency, % 7, % ncy, % % cy, % l, energy car priod, W/m <sup>2</sup> cy period, V	Supply emperatu C C C C C riod, m <sup>3</sup> /hm <sup>2</sup> y, m <sup>3</sup> /hm <sup>2</sup>	n <sup>2</sup>	h/day h/day h/day		n/a         n/a				
Weekdays Saturdays Sundays Ventilation rate, oc Ventilation rate, oc Ventilation rate, no Heat recovery effic Emission efficiency Distribution efficien Automatic control, Generation efficien Energy source (fuel Fans, occupancy pe Fans, non-occupancy	t or cupancy per n-occupanc iency, % 7, % ncy, % % cy, % l, energy can period, W/m <sup>2</sup> cy period, W	Supply emperatu C C C C riod, m <sup>3</sup> /hm <sup>2</sup> y, m <sup>3</sup> /hm <sup>2</sup>	<b>ire</b>	h/day h/day h/day		n/a         n/a				

 <sup>&</sup>lt;sup>15</sup> Department for Education and Skills, Energy and Water Management, A Guide for Schools
 <sup>16</sup> Taken to be Seasonal Coefficient of Performance (SCoP)

Temperature difference	re.		°C		36 7 <sup>18</sup>		
Distribution efficiency			<u> </u>		95		
Automatic control %	y		%		n/a		
Generation efficiency	0%		%		61		
Energy source (fuel e	nergy carrier)		-		Natural gas		
Pumps DHW system	inergy carrier)		W/m <sup>2</sup>		Unknown		
	1		**/111		CHKHOWH		
Part 9: Cooling mod	<u>ie</u>						
	Set-poin	ıt		г	Numetion		
	temperatu	ıre		L			
Weekdays	°C		h/day		n/a		
Saturdays	°C		h/day		n/a		
Sundays	°C		h/day		n/a		
Unoccupied period	°C				n/a		
Holidays	°C				n/a		
Part 10: Cooling sys	stem						
Emission efficiency			%		n/a		
Distribution efficiency	y		%		n/a		
Automatic control			%	n/a			
Generation efficiency			%		n/a		
Fans/pumps room uni	ts		W/m <sup>2</sup>	W/m <sup>2</sup> n/a			
Pumps cooling system	1		W/m <sup>2</sup>		n/a		
Part 11: Mechanica	l ventilation	system (c	ooling mode) (	DNLY EX	XTRACT VENTILATION		
	Supply temperatur	e			Duration		
Weekdays	°C	n/a	h/day		13		
Saturdays	°C	n/a	h/day		0		
Sundays	°C	n/a	h/day		0		
Ventilation rate, occu	pancy period,	m³/hm²			n/a		
Ventilation rate, non-	occupancy, m	<sup>3</sup> /hm <sup>2</sup>			n/a		
Heat recovery efficier	псу, %				n/a		
Night - cooling, m <sup>3</sup> /h	m <sup>2</sup>		n/a				
Free – cooling, m <sup>3</sup> /hm	1 <sup>2</sup>		n/a				

 <sup>&</sup>lt;sup>17</sup> Conserving Water in Further Education Colleges, Building for the Future - Sustainable Construction for Professionals
 <sup>18</sup> Measurement of domestic hot water consumption in dwellings, energy saving trust

Emission efficiency,%			n/a			
Distribution efficiency, %			n/a			
Automatic control, %			n/a			
Generation efficiency, %			n/a			
Fans, occupancy period, V	V/m²		n/a			
Fans, non-occupancy perio	od, W/m²	n/a				
Fans, night cooling, W/m <sup>2</sup>		n/a				
Fans, free-cooling, W/m <sup>2</sup>		n/a				
Part 12: Appliances not	influencing the the	ermal balance				
	Average simultaneous power	r	Duration			
Weekdays	W/m <sup>2</sup>	h/day				
Saturdays	W/m <sup>2</sup>	h/day				
Sundays	W/m <sup>2</sup>	h/day				

## III. Building category: Administrative/Office

#### Subcategory: 1960s Office block

## Table UK3: Administrative buildings/1960s Office block

Building category		Office					
Subcategory		1960s office block					
Conditioned area	$m^2$	2987,64					
Conditioned volume	m <sup>3</sup>	8845					
Climatic zone		Ref. number: WC08LON - Current CIBSE TRY/DSY Hourly Weather Data Set - London City: London					
Part 1: Building (Zone) geometry							
Walls, north	m <sup>2</sup>	410,16					
Walls, east	m <sup>2</sup>	283,81					
Walls, south	m <sup>2</sup>	338,23					
Walls, west	m <sup>2</sup>	285,14					
Windows, north	m <sup>2</sup>	234,96					
Windows, east	m <sup>2</sup>	170,11					
Windows, south	m <sup>2</sup>	252,90					
Windows, west	m <sup>2</sup>	175,65					
Roof	m <sup>2</sup>	648,01					

Floor		$m^2$		64	18,01			
Part 2: Building (Zone) properties	<u>.</u>							
Uwalls		W/m <sup>2</sup> K	ł	Prior to investment 1,60	Requirement at 2014 0,30 <sup>19</sup>			
ΔUtb		W/m <sup>2</sup> K		Calculation bas	sed on psi-values			
b(ground)		-		Included	in U-values			
b(un-conditioned space)		-		Included	in U-values			
b(adjacent sunspace)		-		Included	in U-values			
b(adjacent building)		m <sup>2</sup>		Included	in U-values			
Uwindows		W/m <sup>2</sup> K	F	Prior to investment 6,29	Requirement at 2014 1,8			
fraction of the window frame area		%		1	0 <sup>20</sup>			
g(F)		-		0	,85			
Uroof		W/m <sup>2</sup> K	P	Prior to investment 2,8	Requirement at 2014 0,18			
Ufloor		W/m <sup>2</sup> K	P	Prior to investment 0,53	Requirement at 2014 0,25			
3		-		0,93 <sup>21</sup>				
α		-		0,65				
Infiltration, occupancy period		$\mathbf{h}^{-1}$		1,5				
Infiltration, non occupancy		$h^{-1}$		1,5				
Thermal capacity	1	Wh/m <sup>2</sup> K						
Part 3: Internal gains and operation	onal	<u>l schedule</u>						
Sensible Metabolic heat (occupants)		W/m <sup>2</sup>			6,7			
Latent metabolic heat		W/m <sup>2</sup>			2,2			
Weekdays		h/day			10			
Saturdays		h/day			0			
Sundays		h/day			0			
Lighting for illumination		W/m <sup>2</sup>			15			
Weekdays		h/day			12			
Saturdays		h/day		0				
Sundays		h/day		0				
Lighting, emergency/controls		W/m <sup>2</sup>		Can be neglected compared to lighting for illumination				

 <sup>&</sup>lt;sup>19</sup> Approved Document L2B
 <sup>20</sup> Default value from NCM modelling guide for buildings other than dwellings in England
 <sup>21</sup> Values for typical brick wall, http://www.solarmirror.com/fom/fom-serve/cache/43.html

Weekdays				h	/day								
Saturdays				h	/day								
Sundays				h	/day								
Appliances				V	V/m²			15					
Weekdays				h	h/day 12								
Saturdays				h	/day				0				
Sundays					/day				0				
Latent heat					V/m²				unknow	/n			
Weekdays					/day								
Saturdays					/day								
Sundays				h	/day								
Part 4: Holiday	<u>s</u>												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
No. of holidays (excluding weekends)	3	0	0	2	2	0	0	2	0	0	0	5	
Part 5: Heating mode													
		Set- tempe	point erature		Duration								
Weekdays		°C	22Erroi ookmar not defined	:! k	h/day			13					
Saturdays		°C	12		h/day			13					
Sundays		°C	12		h/da	y				13			
Unoccupied period		°C	12										
Holidays		°C	12										
Part 6: Heating	system	<u>n</u>											
Emission efficien	ncy				%					?			
Distribution effic	eincy				%				9	0			
Automatic contro	ol				%				n	/a			
Generation efficient	ency				%				8	9			
Energy source (fu	uel, ene	ergy car	rier)		-				Natur	al gas			
Fans/pumps roon	n units				W/m <sup>2</sup>	2				?			
Pumps heating sy	/stem				W/m <sup>2</sup>	2				?			
	ng vent	ilation			W/m <sup>2</sup>	2				?			

Part 7: Mechanical ventilation system (heating mode)								
		Supp tempera	oly ature		Duration			
Weekdays		°C		h/da	h/day n/a			
Saturdays		°C		h/day r		n/a		
Sundays		°C		h/day		n/a		
Ventilation rate, occupancy period, m <sup>3</sup> /hm <sup>2</sup>				n/a				
Ventilation rate, non-occupancy, m3/hm2				n/a				
Heat recovery efficiency, %				n/a				
Emission efficiency, %				n/a				
Distribution efficiency, %				n/a				
Automatic control, %				n/a				
Generation efficiency, %				n/a				
Energy source (fuel, energy carrier)				n/a				
Fans, occupancy period, W/m <sup>2</sup>				n/a				
Fans, non-occupancy period, W/m <sup>2</sup>				n/a				
Part 8: Domestic hot water systems								
Quantity			l/m²year		400 <sup>22</sup>			
Temperature difference				°C		36,7 <sup>23</sup>		
Distribution efficiency				%		95		
Automatic control %				%		?		
Generation efficiency %				%		73		
Energy source (fuel, energy carrier)				-		Natural gas		
Pumps, DHW system				W/m <sup>2</sup>		Unknown		
Part 9: Cooling mode								
	Set- tempo	point erature		Duration				
Weekdays	°C	24		h/day		13		
Saturdays	°C	24		h/day		13		
Sundays	°C	Off		h/day		0		
Unoccupied period	°C	Off				0		
Holidays	°C	Off				0		

http://ec.europa.eu/environment/water/quantity/pdf/Water%20Performance%20of%20Buildings\_Study2009.pdf
 Measurement of domestic hot water consumption in dwellings, energy saving trust

Part 10: Cooling system: Local air conditioning only								
Emission efficiency			%	90				
Distribution efficiency			%	80				
Automatic control			%	% n/a				
Generation efficiency			%	<u>%</u> ?				
Fans/pumps room units			W/m <sup>2</sup>	2 ?				
Pumps cooling system			W/m <sup>2</sup>					
Part 11. Mechanical ve	ntilation s	system (co	oling mode)	,				
	Supply temperature		Duration					
Weekdays	°C	17	h/day	13				
Saturdays	°C	17	h/day	13				
Sundays	°C	Off	h/day	0				
Ventilation rate, occupan	cy period, r	n³/hm²						
Ventilation rate, non-occupancy, m <sup>3</sup> /hm <sup>2</sup>								
Heat recovery efficiency,	%		n/a					
Night - cooling, m <sup>3</sup> /hm <sup>2</sup>			n/a					
Free – cooling, m <sup>3</sup> /hm <sup>2</sup>			n/a					
Emission efficiency,%			90					
Distribution efficiency, %	, D		80					
Automatic control, %			n/a					
Generation efficiency, %								
Fans, occupancy period,	W/m <sup>2</sup>							
Fans, non-occupancy per	iod, W/m <sup>2</sup>							
Fans, night cooling, W/m	1 <sup>2</sup>							
Fans, free-cooling, W/m <sup>2</sup>								
Part 12: Appliances no	<u>t influenci</u>	ing the the	rmal balance					
	Ave simultane	erage ous power		Duration				
Weekdays	W/m <sup>2</sup>		h/day					
Saturdays	W/m <sup>2</sup>		h/day					

Sundays

h/day

 $W/m^2$